



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



GS - ES - G786 - 47 EAD

HARVARD UNIVERSITY

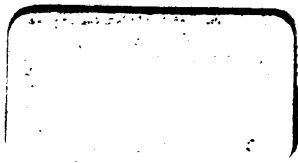


LIBRARY

OF THE

Museum of Comparative Zoölogy

—
BIOLOGICAL
SCIENCES LIBRARY



LIST OF MAPS, SECTIONS, AND PUBLICATIONS OF THE GEOLOGICAL SURVEY.

The Maps are those of the Ordnance Survey, geologically coloured by the Geological Survey of the United Kingdom, under the Superintendence of ARCH. GEIKIE, LL.D., F.R.S., Director General.
For Maps, Sections, and Memoirs illustrating Scotland, Ireland, and the West Indies, and for full particulars of all publications, see "Catalogue." Price 1s.)

ENGLAND AND WALES.—(Scale one-inch to a mile.)

Maps marked * are also published as Drift Maps. Those marked † are published only as Drift Maps.

Sheets 3*, 5, 6*, 7*, 8*, 9, 11 to 22, 25, 26, 30, 31, 33 to 37, 40, 41, 44, 47*, 64*, 65†, 69†, 70*, 83*, 86*, price 8s. 6d. each.
Sheet 4, 5s. Sheets 2*, 10, 23, 24, 27 to 29, 32, 38, 39, 58, 84†, 85†, 8s. each.
Sheets divided into quarters; all at 3s. each quarter-sheet, excepting those in brackets, which are 1s. 6d. each.
1*, 42, 43, 45, 46, NW, SW, NE†, SE, 48, NW†, SW*, NE†, (SE*), (49†), 50†, 51*, 52 to 57 (57 NW), 59 to 63, 66 SW†, NE†, NW*, SE†, 67, N†, (St), 68 NE†, (NW*), SW†, 71 to 75, 76. (N) 8, (77 N), 78, 79, NW*, SW NE*, SE*, 80 NW*, SW*, NE*, SE, 81 NW*, SW, NE, SE, 82, 83*, 87, 88, NW, SW, NE, SE, 89 NW*, SW*, NE, SE*, 90 (NE*), (SE*), 91, (NW*), (SW*), NE*, SE*, 92 SW*, SE, 93 NW, SW, NE*, SE*, 94 NW†, SW†, (NE†), SE†, 95 NW*, NE*, (SE*), 96*, 97 SE, 98 NW, NE*, SE, 99 (NE*), (SE*), 101 SE, 102 NE*, 103*, 104*, 105 NW, SW, (NE*), SE, 106 NE* SE*, 109 SW, SE*, 110 (NW*), (NE*), SW*.

HORIZONTAL SECTIONS,

1 to 139, England, price 5s. each.

VERTICAL SECTIONS,

1 to 76, England, price 8s. 6d. each.

COMPLETED COUNTIES OF ENGLAND AND WALES, on a Scale of one-inch to a Mile.

Sheets marked * have Descriptive Memoirs.

Sheets or Counties marked † are illustrated by General Memoirs.

ANGLESEY†,—77 N, 78. Hor. Sect. 40.
BEDFORDSHIRE,—46 NW, NE, SW†, SE†, 52 NW, NE, SW, SE.
BERKSHIRE,—7*, 8†, 12*, 13*, 34*, 45 SW*. Hor. Sect. 59, 71, 72, 80.
BRECKNOCKSHIRE†,—36, 41, 42, 56 NW, SW, 57 NE, SE. Hor. Sect. 4, 5, 6, 11, and Vert. Sect. 4 and 10.
BUCKINGHAMSHIRE,—7* 13* 45* NE, SE, 46 NW, SW†, 52 SW. Hor. Sect. 74, 79.
CAERNARVENSHPRE†,—37, 38, 40, 41, 42 NW, SW, 56 SW, 57 SW, SE. Hor. Sect. 2-4, 7, 8; and Vert. Sect. 3-6, 13, 14.
CAERNARVONSHIRE†,—74 NW, 75, 76, 77 N, 78, 79 NW, SW. Hor. Sect. 28, 31, 40.
CAMBRIDGESHIRE†,—46 NE, 47*, 51*, 52 SE, 64*.
CARDIGANSHIRE†,—40, 41, 56 NW, 57, 58, 59 SE, 60 SW. Hor. Sect. 4, 5, 6.
CHESHIRE,—73 NE, NW, 79 NE, SE, 80, 81 NW*, SW*, 88 SW. Hor. Sect. 18, 43, 44, 60, 64, 65, 67, 70.
CORNWALL†,—24†, 25†, 26†, 29†, 30†, 31†, 32†, & 33†.
DENBIGH†,—73 NW, 74, 75 NE, 78 NE, SE, 79 NW, SW, SE, 80 SW. Hor. Sect. 31, 35, 38, 39, 43, 44; and Vert. Sect. 24.
DERBYSHIRE†,—62 NE, 63 NW, 71 NW, SW, SE, 72 NE, SE, 81, 82, 88 SW, SE. Hor. Sect. 18, 46, 60, 61, 69, 70.
DEVONSHIRE†,—20†, 21†, 22†, 23†, 24†, 25†, 26†, & 27†. Hor. Sect. 19.
DORSETSHIRE,—15, 16, 17, 18, 21, 22. Hor. Sect. 19, 20, 21, 22, 56. Vert. Sect. 22.
ESSEX,—1*, 2*, 47*, 48. Hor. Sect. 84, 120.
FLINTSHIRE†,—74 NE, 79. Hor. Sect. 43.
GLAMORGANSHIRE†,—20, 36, 37, 41, & 42 SE, SW. Hor. Sect. 7, 8, 9, 10, 11; Vert. Sect. 2, 4, 5, 6, 7, 9, 10, 47.
GLOUCESTERSHIRE,—19, 34*, 35, 43 NE, SW, SE, 44*. Hor. Sect. 12 to 15, 59; Vert. Sect. 7, 11, 15, 46 to 51.
HAMPSHIRE,—8†, 9†, 10†, 11†, 12*, 14, 15, 16. Hor. Sect. 80.
HEREFORDSHIRE,—42 NE, SE, 43, 55, 56 NE, SE. Hor. Sect. 5, 13, 27, 30, 34; and Vert. Sect. 15.
HERTFORDSHIRE,—1† NW, 7*, 46, 47*. Hor. Sect. 79, 120, 121.
HUNTINGDON,—51 NW, 52 NW, NE, SW, 64*, 65.
KENT†,—1† SW & SE, 2†, 3†, 4†, 6†. Hor. Sect. 77 and 78.
LANCASHIRE,—79 NE, 80 NW*, NE, 81 NW, 88 NW, SW†, 89, 90, 91, 92 SW, 98. H. S. 62 to 68, 85 to 87. V. S. 27, 34, C.
LEICESTERSHIRE,—53 NE, 62 NE, 63*, 64*, 70*, 71 SE, SW. Hor. Sect. 46, 48, 49, 52, 122, 124, 125.
LINCOLNSHIRE†,—64*, 65, 69, 70*, 83*, 84*, 85*, 86*.
MERIONETHSHIRE†,—59 NE, SE, 60 NW, 74, 75 NE, SE. Hor. Sect. 26, 28, 29, 31, 32, 35, 37, 38, 39.
MIDDLESEX†,—1† NW, SW, 7*, 8†. Hor. Sect. 79.
MONMOUTHSHIRE,—35, 36, 42 SE, NE, 45 SW. Hor. Sect. 5 and 12; and Vert. Sect. 3, 9, 10, 12.
MONTGOMERYSHIRE†,—56 NW, 59 NE, SE, 60, 74 SW, SE. Hor. Sect. 23, 27, 29, 30, 32, 34, 35, 36, 38.
NORFOLK†,—50 NW*, NE*, 64*, 65*, 66*, 67, 68*, 69.
NORTHAMPTONSHIRE,—64, 45 NW, NE, 46 NW, 52 NW, NE, SW, 53 NE, SW, & SE, 63 SE, 64.
NOTTINGHAM,—70*, 71* NE, SE, NW, 82 NE*, SE*, SW, 83, 86, 87* SW. Hor. Sect. 60, 61.
OXFORDSHIRE,—7*, 13*, 34*, 44*, 45*, 53 SE*, SW. Hor. Sect. 71, 72, 81, 82.
PEMBROKESHIRE†,—33, 39, 40, 41, 58. Hor. Sect. 1 and 2; and Vert. Sect. 12 and 13.
RADNORSHIRE,—42 NW, NE, 56, 60 SW, SE. Hor. Sect. 5, 6, 27.
RUTLANDSHIRE†,—this county is wholly included within Sheet 64*.
SHROPSHIRE,—55 NW, NE, 56 NE, 60 NE, SE, 61, 62 NW, 73, 74 NE, SE. Hor. Sect. 24, 25, 30, 33, 34, 36, 41, 44, 45, 53, 54, 58; and Vert. Sect. 23, 24.
SOMERSETSHIRE,—18, 19, 20, 21, 27, 35. Hor. Sect. 15, 16, 17, 20, 21, 22; and Vert. Sect. 12, 46, 47, 48, 49, 50, 51.
STAFFORDSHIRE,—54 NW, 55 NE, 61 NE, SE, 62, 63 NW, 71 SW, 72, 73 NE, SE, 81 SE, SW. Hor. Sect. 18, 24, 25, 41, 42, 45, 49, 54, 57, 51, 60; and Vert. Sect. 16, 17, 18, 19, 20, 21, 23, 26.
SUFFOLK,—47*, 48*, 49, 50, 51, 66 SE*, 67.
SURREY,—1 SW†, 6†, 7*, 8†, 12†. Hor. Sect. 74, 75, 76, and 79.
SUSSEX,—4*, 5†, 6†, 8†, 9†, 11†. Hor. Sect. 73, 75, 76, 77, 78.
WARWICKSHIRE,—44*, 45 NW, 53*, 54, 62 NE, SW, SE, 63 NW, SW, SE. Hor. Sect. 23, 48 to 51; Vert. Sect. 21.
WILTSHIRE,—12*, 13*, 14, 15, 18, 19, 34*, and 35. Hor. Sect. 15 and 59.
WORCESTERSHIRE,—43 NE, 44*, 54, 55, 62 SW, SE, 61 SE. Hor. Sect. 13, 23, 25, 50, 59, and Vert. Sect. 15.

GENERAL MEMOIRS OF THE GEOLOGICAL SURVEY.

REPORT ON CORNWALL, DEVON, and WEST SOMERSET. By Sir H. T. DE LA BECHE. 14s. (O.P.)
FIGURES and DESCRIPTIONS OF THE PALÆOZOIC FOSSILS in the above Counties. By PROF. PHILLIPS. (O.P.)
The MEMOIRS OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN. Vol. I., 21s.; Vol. II. (in 2 Parts), 42s.
NORTH WALES. By Sir A. C. RAMSAY. Appendix, by J. W. SALTER and R. ETHERIDGE. 2nd Ed. 21s. (Vol. III. of Memoirs, &c.)
LONDON BASIN. Pt. I. Chalk and Eocene of S. and W. Tracts. By W. WHITAKER. 13s. (Vol. IV. of Memoirs, &c.)
Guide to the GEOLOGY of LONDON and the NEIGHBOURHOOD. By W. WHITAKER. 4th Ed. 1s.

[All Rights Reserved.]

MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

THE GEOLOGY OF THE COUNTRY AROUND EAST DEREHAM.

(EXPLANATION OF QUARTER-SHEET 66 N.W.)

BY

J. H. BLAKE, F.G.S., ASSOC. M. INST. C.E.

(PARTS BY H. B. WOODWARD, F.G.S., AND F. J. BENNETT, F.G.S.)

~~~~~  
PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.  
~~~~~



LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE,
BY EYRE AND SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

And to be purchased, either directly or through any Bookseller, from
EYRE AND SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C., or
ADAM AND CHARLES BLACK, 6, NORTH BRIDGE, EDINBURGH; or
HODGES, FIGGIS, & Co., 104, GRAFTON STREET, DUBLIN.

1888.

Price One Shilling and Sixpence.

Notice

NOTICE.

THE greater part of the area described in the following Memoir was surveyed by MR. J. H. BLAKE, under the superintendence of MESSRS. W. WHITAKER and H. B. WOODWARD; but small parts in the north-west and north-east corners of the Map were surveyed by MR WOODWARD, and other parts near the south-west and south-east corners were surveyed by MR F. J. BENNETT.

The Memoir, which has been edited by MR. WHITAKER, was written by MR. BLAKE, with the assistance of such notes as have been supplied by MESSRS. WOODWARD and BENNETT for the areas surveyed by them. The lists of fossils have been revised by MESSRS. G. SHARMAN and E. T. NEWTON.

Only one edition of the Map is published, that showing the drift, as well as the solid rocks, where the latter are not obscured by overlying superficial deposits.

H. W. BRISTOW,
Senior Director.

Geological Survey Office,
28, Jermyn Street, S.W.,
30th June 1888.

CONTENTS

	PAGE
NOTICE, by the Senior Director	ii
CHAPTER I. INTRODUCTION. Area. Rivers. Geological Formations. Form of the Ground and its Origin	1
CHAPTER II. CHALK General Remarks. Local Details (Northern Side of the Wensum Valley. Southern Side of the Wensum Valley. Western and Southern Tracts). List of Fossils	5
CHAPTER III. PEBBLY SERIES. General Remarks. Local Details	14
CHAPTER IV. GLACIAL DRIFT. LOAM WITH BOULDERS. (LOWER BOULDER CLAY.) General Remarks. Local Details (Northern Side of the Wensum Valley). Local Details (Southern Side of the Wensum Valley). Local Details (Southern Tract)	18
CHAPTER V. GLACIAL DRIFT (<i>continued</i>). SAND AND GRAVEL. (MIDDLE GLACIAL OF WOOD.) General Remarks. Local Details (North of the Wensum). Local Details (West and South of the Wensum). Local Details (Southern Tract, and around East Dereham)	22
CHAPTER VI. GLACIAL DRIFT (<i>continued</i>). UPPER BOULDER CLAY. General Remarks. Local Details (North of the Wensum Valley). Local Details (West and South of the Wensum Valley)	29
CHAPTER VII. POST-GLACIAL BEDS. GRAVEL, SAND, AND LOAM. (PLATEAU DRIFT.) General Remarks. Local Details	39
CHAPTER VIII. POST-GLACIAL BEDS (<i>continued</i>). VALLEY GRAVEL. General Remarks. Local Details. Ouse System (Valley of the Nar or Setchy. Valley of the Wissey or Stoke). Local Details. Yare System (Valley of the Yare. Valley of the Wensum). ALLUVIUM. General Remarks. Local Details (Valley of the Wensum. Valley of the Nar or Setchy)	46
CHAPTER IX. ECONOMIC RESOURCES. Building-stones. Whitening and Lime. Road-metal. Brickearths and Sand. Manures. Water	50
APPENDIX. WELL-SECTIONS	54
INDEX	57

LIST OF ILLUSTRATIONS.

	PAGE
Fig. 1. Section in the Chalk Pit S. of Sparham Church - -	6
Fig. 2. Section at the Lime-kiln half a mile N. of Swanton Morley Church - - - - -	9
Fig. 3. Section at the Lime-kiln S.E. of Lyng Church - -	9
Fig. 4. Section in a Pit just S.W. of Ringland Church - -	16
Fig. 5. Section in a Pit N.W. by W. of Elsing Church - -	21
Fig. 6. Section in a Pit in Bylaugh Park, N.E. of the Church -	32
Fig. 7. Section in a Pit a mile N.E. by N. of North Elmham Church	42
Fig. 8. Section in a Pit E.S.E. of Colton Church - - -	44

THE GEOLOGY OF THE COUNTRY AROUND EAST DEREHAM.

CHAPTER I. INTRODUCTION.

AREA.

THE district treated of in this Memoir occupies the central portion of Norfolk, and embraces an area of about 205 square miles. It includes the towns of East Dereham, Litcham, and Reepham; and North Elmham (once a city and the seat of the Bishops of Norfolk from A.D. 673 to A.D. 1075), and the villages of Necton, Shipdham, Mattishall, Ringland, Lyng, Swanton Morley, Tittleshall, and others of smaller size.

RIVERS.

1. The *Wensum* enters the area a little north of North Elmham, and after following a very serpentine course in a south-easterly direction, leaves the district a short distance south-east of Ringland; whence it flows through Norwich to its outlet to the North Sea at Gorleston (south of Yarmouth).

It receives, in the area under consideration, three important tributary streams. One, on the southern side, rises at Fransham, and flows eastwards to Rush Meadow, near East Dereham, then northwards by Gressenhall to its junction at Worthing, south of North Elmham. One, on the northern side, flows southwards by Reepham and Whitwell Common to its junction at Lenwade; and another, also on the northern side, flows southwards from Brandiston Common, by Swannington (another stream uniting with it there) and Alderford to Morton Warren, near Attlebridge, where it unites with the main river. There are also other smaller streams which flow into some of these tributaries, or directly into the main channel of the Wensum.

Another important tributary rises south of East Dereham, and flows eastwards by North Tuddenham, Honingham, and Easton, where it leaves our area, and continues its course in the same direction to Hellesdon, about 2 miles W.N.W. of Norwich, where it falls into the main river.

2. The *Yare*, or that portion of it known as the *Blackwater*, rises near Shipdham, and flows in a circuitous course by Cranworth, Southburgh, and Reymerstone to near Hardingham Mills, where it is joined on the northern side by a stream coming in a south-easterly direction from Whinburgh through Thuxton. These united streams form the Yare, which continues an easterly course by Runhall, Barnham Broom, Bickerstone, Marlingford (near where a tributary enters) to Bauburgh, where it leaves the district, and, flowing past Earlham and Cringleford, joins the Wensum near Trowse, S.E. of Norwich.

3. The *Nar* or *Setchy* rises at Mileham, and flows westwards to Litcham, where it is joined by a stream on the southern side coming from Great Dunham and Beeston: it then continues its westerly course, leaves the district south of Lexham Hall, and eventually enters the Eau Brink Cut of the Great Ouse River at Lynn.

4. The *Wissey* or *Stoke* rises at East Bradenham, and flows westwards by West Bradenham and Holm Hale, to Ernesford, where it leaves the district, having received in its irregular course several smaller streams. It then continues its westerly course to Stoke Ferry, and finally enters the Great Ouse between Denver and Hilgay.

GEOLOGICAL FORMATIONS.

The following Table exhibits the various formations that occur in the district, and which are shown by distinctive colours on the Geological Survey Map:—

Recent	-	Alluvium.
Post-Glacial Drift	-	{ Valley Gravel. Gravel, Sand, and Loam. [Plateau Gravel, &c.]
Glacial Drift	-	{ Boulder Clay (Upper). Sand and Gravel. [Middle Glacial of Mr. Wood.]
Pebbly Series	-	{ Loam, with Boulders. [Lower Glacial.] Gravel and Sand. [Bure Valley Beds of Mr. Wood.]
Cretaceous	-	Chalk.

The order of superposition or relative geological age and succession of the formations, as given in the above table, are clearly demonstrated in this district by the geological mapping of the Wensum Valley, and by the well-boring at East Dereham.

All the five Drift-deposits (including the Pebbly Series) are present in the eastern and northern parts of the district, and also in the central, with the exception of the Pebbly Series, which is absent beneath East Dereham, the Lower Glacial Loam there resting on the Chalk. In the westward portion of the district, each of the different Glacial deposits seems to repose successively upon the Chalk, thus corresponding with what has been observed in Suffolk, in the neighbourhood of Bury St. Edmunds and elsewhere, where the Glacial gravels (overlaid by the Boulder Clay) are to be seen reposing upon the Chalk, whilst farther west the Boulder Clay takes that position.

The same order of superposition of these five deposits is to be seen in vertical succession in the cliff on the coast at Corton, in Suffolk.* The lowermost, the Pebbly Series, there, however, instead of resting on the Chalk, rests on the Pliocene "Rootlet-bed" or so-called "Forest-bed." That this sequence extends from the Norfolk and Suffolk coast to this central portion of Norfolk seems evident. All the formations, however, are not always present, owing to local denudation or otherwise. Here and there, also, local modifications and variations in the formations are to be observed.

FORM OF THE GROUND, AND ITS ORIGIN.

With regard to the physical features of the district, and their origin, a glance at the Geological Survey Map will convey a better impression to the mind than any mere verbal description could do.

In order to account for the present form of the ground, for the various soils and sub-soils, and for their mode of occurrence, a knowledge of the formations entering into its underground structure is essential. If we could remove the whole of the Recent and Drift deposits we should probably see an inclined plane of Chalk, with a very irregular surface, and sloping more or less in an easterly or south-easterly direction. On this inclined plane (not then necessarily at its present angle, for it has since been upheaved, in all probability) the Drift formations were deposited in the order given in the table, commencing with the Pebbly Series, not, however, over the whole area, but only over the eastern and north-eastern portions. Then succeeded the Lower Glacial Stony Loam, which spread over a larger area, going further westward up the incline; this was followed by the Glacial sands and gravels, spreading out still further in the same direction; and these were succeeded by the Upper Boulder Clay, which spread over the whole district. All this may possibly have taken place during or after subsidence of the land, and in a shallow sea, with glacial conditions existing during the deposition of the two Boulder Clays of different origin, and with perhaps a warmer period during the deposition of the sands and gravels.† The breaking up of the intense glacial conditions was apparently accompanied by an upheaval of the Glacial Drift, and the distribution of the coarse Plateau Gravels by powerful currents of water. During or about this period the Boulder Clay received a thin covering of loam and sand in places, resulting probably from a natural process of "warping" or subsidence from muddy waters. It was at this period also that a considerable quantity of the Boulder Clay was apparently denuded or washed away, and that the general form of the ground, to a large extent as it now appears, was carved out.

* See "Sections of the Suffolk Cliffs at Kessingland and Pakefield, and at Corton." *Geological Survey Horizontal Sections*, Sheet 128.

† See H. B. Woodward, *Proc. Geol. Assoc.*, vol. ix., no. 3, p. 113 (1885).

Rain, rivers, snow, ice, wind, chemical agency, &c. have ever since been at work, but in a minor degree, in sculpturing and modifying the form of the ground that was produced or roughly outlined at that early period, and which brought about the present drainage-system and physical features.

The highest ground occurs in the western portion of the area, at Little Fransham, where it is about 270 feet above Ordnance Datum. This and the contiguous high ground forms the watershed or water-parting of several rivers and streams. The Nar or Setchy, and the Wissey or Stoke, have their origin in the neighbourhood, and flow westward into the Ouse; and the Yare and several important tributaries of the Wensum also have their origin here, but flow eastward, and, after uniting in the neighbourhood of Norwich, continue their course to their common outlet to the North Sea, south of Yarmouth.* There is, however, little or no perceptible amount of valley-excavation going on now, the streams and rivers for the most part merely following sinuous courses in their own alluvial deposits; their tendency being now to silt up, rather than to excavate, excepting in some cases where there is a slight deepening of their alluvial channels.

The extensive remains of the once continuous sheet of Boulder Clay form the heavy or stiff lands of the district; and the Glacial sands, which are only exposed along the slopes of the valleys and in other places where the previous covering of Boulder Clay has been removed, are known mostly as the light lands. On the high ground, the surface of the Boulder Clay presents its usual flat appearance, forming a comparatively level plateau, and intersected, for drainage-purposes, with numerous ditches, which form a favourite habitat of the primrose. This otherwise uninteresting and monotonous tract is relieved by trees along the road-sides and hedge-rows, and here and there by small woods and plantations. The most picturesque scenery occurs in the lower part of the valleys, where the Chalk and Glacial loams, sands, and gravels are exposed, particularly in the neighbourhood of Ringland, and other eastern and south-eastern portions of the district.

The Ordnance Survey has published various heights in our district, many of which are marked on the Map, along or near the high road from west to east through Dereham. These vary from 85 feet above Ordnance Datum, or mean sea-level, on the bridge opposite the water-mill at Honingham, to 268 feet on the road in front of Ling-end Farm, Little Fransham.

* For further information respecting the River Yare, see *Geological Survey Memoirs* "On the Geology of the Country around Norwich," and "On the Geology of the Country near Yarmouth and Lowestoft."

CHAPTER II. CHALK.

GENERAL REMARKS.

THE Chalk is the basement-rock of the district, and is to be seen in places in the lower part and on both sides of the Wensum Valley, and also in a similar position in the valleys near the four corners of the area. It is covered, for the most part, by a considerable thickness of Drift deposits, and is only exposed where these latter have been cut through by denudation.

The depth at which the Chalk occurs beneath this covering of superficial deposits varies much throughout the district. At East Dereham Water Works (see p. 54), in the central portion of the area, the Chalk was proved at a depth of 120 feet; whilst at Bylaugh Park it was stated to be 80 feet down (see p. 54).

The Chalk is mostly soft in texture, and white, but occasionally it is yellowish; it is often thinly bedded and frequently in a more or less lenticular manner, and everywhere contains very irregular-shaped nodules of flint. These flints occur sometimes along the planes of bedding, and sometimes irregularly here and there throughout the mass of the Chalk.

Mr. S. WOODWARD divided the Chalk of this area into "Upper" and "Medial," as shown on his Geological Map of Norfolk (1833). The eastern portion was considered by him as Upper, and the western, in the neighbourhood of Litcham, &c., as Medial. He states that the Medial Chalk "is of a closer texture than the Upper, and has fewer flints."* His grandson, Mr. H. B. WOODWARD, considers the Chalk at Litcham to be harder than that at Norwich (see p. 10).

All the chalk-pits in the district were searched for fossils by Mr. John Rhodes (the fossil-collector of the Geological Survey) in 1884, and most of them yielded some specimens, which are mentioned in the list, p. 12. They were identified by Messrs. G. Sharman and E. T. Newton. Some were obtained from the chalk, and others from the flints in it.

LOCAL DETAILS.

Northern Side of the Wensum Valley.

Billingford.—There is a large chalk-pit, now much over-grown with trees and brushwood, on the low ground about three eighths of a mile N.N.E. of the Norfolk County School. The Chalk in places was well exposed; it was

* *Geology of Norfolk*, p. 28. For information respecting the Subdivisions of the Chalk, see A. J. JUKES-BROWNE, *Proc. Norwich Geol. Soc.*, pt. v., p. 113 (1881).

very thinly and irregularly bedded, contained many black flints with a white coating, but not apparently in layers. It had an irregular surface, and had been excavated to a depth of 15 feet. In one place, resting in a hollow in the Chalk, there was a remnant of the Pebbly Sand, at least 2½ feet in thickness; consisting of brown and ferruginous sand with numerous black flint pebbles. On the western and southern sides of the pit there was some grey loamy clay overlaid with sand (Glacial Sand on Lower Glacial Loam).

At the pit nearly seven eighths of a mile N.N.E. of North Elmham Church, close to the Norfolk County School, on the lower part of the slope, the Chalk was soft and rubbly, and contained flints.

The fossils found in these two pits are marked in the list, p. 11.

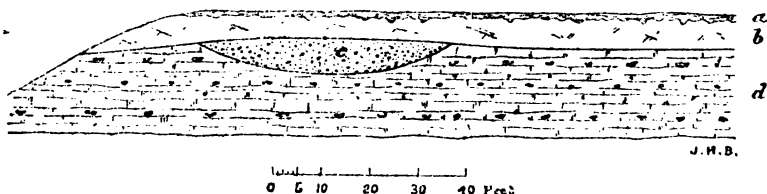
Bylaugh.—The section here is described on p. 19.

Sparham.—The chalk in the pit a mile W. of Lenwade Bridge, at the rifle-butts adjoining the marsh-land, was white, soft, showed in places irregular thin bedding, and contained small black flints, not apparently in layers but occurring irregularly. Several small "pipes," averaging about 3 feet in depth, occurred in the Chalk, of which the thickness shown was about 9 feet. The Chalk was overlaid by Lower Glacial brown loam, 9 feet thick, and with small flints; the loam by buff Glacial sand, 20 feet thick, and the latter by Boulder Clay on the high ground.

A pit three quarters of a mile S. of Sparham Church, on the sloping ground on the northern side of the valley and adjoining the marsh, gave the section shown in Fig. 1.

FIG. 1.

Section in the Chalk Pit S. of Sparham Church.



a. Soil.

b. Lower Glacial. Fine marly loam, with an even, but slightly undulating, line at the base, 6 to 7 feet.

c. Pebbly sand. Lenticular patch (50 feet long, up to 7 feet thick) of buff and whitish sand, containing numerous black flint-pebbles, with a few of quartz, on the western side.

d. Chalk, thinly and more or less lenticularly bedded: with large irregular-shaped flattish flints, and many smaller ones; 18 feet.

In a small pit in a field on sloping ground half a mile S.S.W. of Sparham Church, the Chalk was shown to be overlain by Lower Glacial stony loam, 3 feet thick, with pebbles of black flint and of quartz.

At another small pit north of the above, in an adjoining field, but on higher ground, 6 feet of loam was shown overlying the Chalk.

In a pit, a mile W.S.W. of Sparham Church, the Chalk had been excavated to a depth of about 18 feet, and was overlain by from 2 to 3 feet of brown Lower Glacial loam.

A little N.W. of the above, and east of Sparham Old Plantation, a small pit showed Chalk underlying a considerable thickness of Lower Glacial loam.

Fossils were found in the pits west of Lenwade Bridge, south of Sparham Church, W.S.W. of the same, and at the old lime-kiln, three quarters of a mile S.W. by W. of Sparham Church (see p. 11).

Whitwell.—Chalk was exposed in the road-cutting N. of Whitwell railway station (see p. 15), as well as in the road on the low ground S.W. of the bridge. During the excavation for the bridge (the foundations of which rest on the Chalk) several human skeletons were discovered close together in a

sitting posture entombed in the Chalk, an excavation having been made for the purpose. A little Valley Gravel overlaid the Chalk at this spot.

Chalk was observed in various places underlying the alluvium N. of Whitwell Common.

The sections made during the construction of the railway are described on p. 15.

Great Witchingham.—At the pit five eighths of a mile W. of Alderford Church, on the northern side of the road N. of Witchingham Hall, the Chalk was white, soft, thinly and irregularly bedded, and slightly contorted. Yellowish and brownish stains occurred along the planes of bedding, and many small irregular-shaped flints in varicous parts, but not apparently in layers. The Chalk was exposed to a depth of 12 feet, and was overlaid by pebbly gravel from 10 to 12 feet thick, like much-rolled beach-shingle, and consisting of flint pebbles with some small quartz pebbles, and a little orange-coloured sand in places, more especially at the base, where the deposit was ferruginous. Four "pipes" were shown in the Chalk, the largest being 6 feet in depth, and from 8 to 12 inches or more in diameter: they were vertical and filled with gravel.

Another large pit opposite the above, on the southern side of the road, has been overgrown for many years.

Soft rubbly chalk was seen in a pit on the eastern side of the railway, three quarters of a mile W. by N. of Great Witchingham Church, and similar chalk, with flints, in pits half a mile W.S.W. of the church, by the roadside three eighths of a mile W. by S. of the same, and five eighths of a mile S. of it.

Fossils were found in all but the second of the pits (overgrown) in this parish, see p. 11.

Alderford.—At a pit half a mile W.S.W. of the church, and to the east of the grounds of Witchingham Hall, from 18 to 20 feet or more in depth of Chalk was exposed; it was soft and white, with yellowish and ferruginous or rusty layers along the bedding, which latter was undulating and otherwise irregular. Numerous irregular-shaped flints, from about 6 inches to a foot in length, occurred sometimes along the planes of bedding, at others at various distances throughout the Chalk. Pebbly gravel, from 6 to 8 feet thick, in places overlaid the latter, but with some white marl intervening in places. There was also a little disturbed chalk. The following fossils were procured from the Chalk:—*Ventriculites*, sp., and *Belemnitella quadrata*, DeFr.

Swannington.—From the large chalk-pit on Alderford Common, half a mile S.E. of Alderford Church, the species in the list, p. 11, were obtained. On the eastern side of the pit were some good sections, showing Glacial loam overlying pebbly gravel, 10 feet or more thick, above the Chalk.

Attlebridge.—In the large pit three eighths of a mile S.E. of the church, on the northern side of the road, a little more than 20 feet in depth of Chalk was exposed. It was white, soft, thinly bedded, and had brown ferruginous stains in places. Numerous irregular-shaped black flints, with a very thin white coating, occurred: some in the upper part lay in a very irregular manner, presenting the appearance of a disturbance of the Chalk, but not apparently a re-construction. Pebbly gravel or shingle and sand, 5 to 10 feet thick (thickest on the south) overlaid the Chalk. The sand was buff and orange-coloured, and in places contained some patches of grey loamy clay. The Chalk appeared as if part of the valley had been excavated before the deposition of the pebbly gravel, or else this lies in irregular cavities in the Chalk.

Another pit on the same side of the road, about three quarters of a mile S.E. of the church, and about 250 yards E. of Attlebridge Hall, gave the following section:—

Drift.—Mottled brown and grey loam, in places; 3 to 4 feet.

Pebbly Series.—Gravel and sand, roughly stratified parallel to the Chalk slope, thickest on the south (as before): at the base about 3 feet of more or less indurated reddish-brown sand; from 12 to 14 feet.

Chalk.—White, weathering yellowish in places, with many flints and a few paramoudras, thin-bedded and with ferruginous stains along the planes of bedding; about 18 feet shown.

The Chalk had the appearance of having been excavated on the southern side, as if the slope of the valley had been partially excavated before the deposition of the gravel.

About five eighths of a mile south-eastward from the above, and a mile and five eighths from Attlebridge Church, a chalk-pit occurs on the southern side of the road.

The fossils found in these three pits are named in the list, p. 11.

Attention was drawn to the disturbed or re-constructed chalk near Attlebridge by Dr. J. E. TAYLOR.*

Taverham.—"East of Ringland Low Common a pit showed Chalk with flints, the upper part of which was disturbed to a depth of more than 2 feet. Traces of laminated clay and pebbly gravel occurred in pockets on the top."†

In a pit nearly three quarters of a mile S.E. of Ringland Church, on the sloping ground on the eastern side of the River Wensum, in a locality known as Ringland Wood, the Chalk was soft and rubbly and contained flints, and fossils were found here (see p. 11).

Southern Side of the Wensum Valley.

North Elmham.—The Chalk had been excavated to a depth of 12 feet in a pit on the sloping ground, a little more than a quarter of a mile N.N.E. of the church. It was very thinly and irregularly bedded, and contained numerous flints throughout, but not apparently in layers. The Chalk was overlaid, on the northern side, by from 1½ to 6 feet of stratified sand and loam, and the latter was overlaid by from 4 to 10 feet of very chalky Boulder Clay. This clay seemed to dip down the slope, cutting off the stratified sand and loam. On the southern side there was above the Chalk at least 3 feet of coarse pebbly gravel, capped by 9 or 10 feet of hard stiff Boulder Clay. The following fossils were obtained from the Chalk:—*Inoceramus* (fragment), *Belemnitella quadrata*, *Ventriculites*, sp., and *Spongia*, sp.

Swanton Morley.—In a small pit on the low ground adjoining the marsh-land, a little more than 200 yards N.E. of the church, about 6 feet of Chalk was exposed in a clean-cut section.

Chalk also occurs at the farm-buildings south of the ruins of Swanton Morley Castle, and it is here overlaid by 8 or 10 feet or more of stony marl (re-constructed chalk), which latter is overlaid by Glacial Loam, Sand, and Boulder Clay.

A fine section was exposed in 1883 at the lime-kiln half a mile N. of Swanton Morley Church (see Fig. 2), and the following fossils were got:—*Parasmilia centralis*, a piece of Echinoderm spine, plates of *Cidaris*, *Idmonea*, sp., and *Pecten nitidus*.

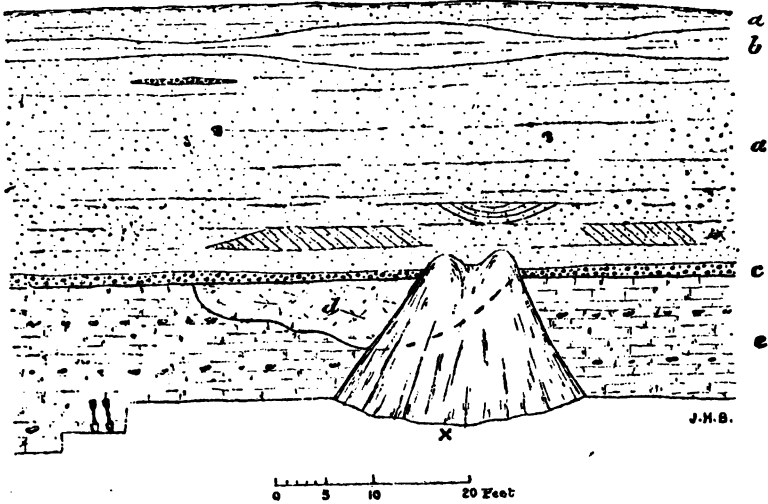
Lyng.—A good section of Chalk was well exposed in 1883 at the lime-kiln about five eighths of a mile S.E. of the church. (See Fig. 3.) At a pit three quarters of a mile W. of Lyng Church, the Chalk was soft and rubbly. The names of the fossils from these two pits are given in the list, p. 11.

* *Geol. Mag.*, vol. vi., p. 509 (1869).

† From Mr. H. B. WOODWARD's notes.

FIG. 2.

Section at the Lime-kiln half a mile N. of Swanton Morley Church.

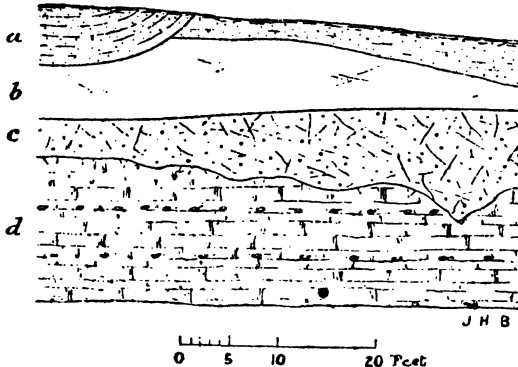


x Talus.

- Glacial Drift. {
- a. Orange and buff stratified sand, with a little grey here and there, false-bedded in places; 24 to 27 feet, in which is:—
 - b. More or less stratified brown stony loam, lenticular, and whitish-brown in the lower part; 2 to 5 feet.
 - c. Flint gravel, resembling shingle; 1 to 1½ feet.
 - d. Loam, lying in an eroded hollow in the Chalk.
- e. Chalk, soft, thinly bedded, and containing very irregular-shaped black flints with white coating (many of a flat and irregular roundish shape, one 20 inches long and 4 thick; some occur larger), also lumps of iron-pyrites, from 3 to 4 inches in diameter. Water rises in the lowest part; 12 to 17 feet.

FIG. 3.

Section at the Lime-kiln S.E. of Lyng Church.



- Glacial Drift. {
- a. Stratified buff sand, resting unconformably on the next; 2 to 6 feet +
 - b. Unstratified brown loam; 7 feet.
- c. Pebbly Series.—Marl or reconstructed Chalk with scattered pebbles of black flint; 4 to 12 feet.
- d. Chalk, rubbly, and with flints; 12 to 15 feet.

Weston.—A large chalk-pit occurs on the sloping ground three eighths of a mile S.S.W. of Lenwade Bridge, on the south side of, and adjoining the Alluvium south-west of Weston Old Hall. From 18 to 20 feet in depth of soft white chalk was exposed, containing yellowish seams in places, and many flints in irregular positions. The following fossils were obtained:—*Spongia*, sp., *Cyphosoma*, sp. (fragment), and *Belemnitella quadrata*.

Morton.—At a pit nearly half a mile N.W. by N. of the church on the sloping ground at Scotch Hills, and at the lime-kiln pit half a mile N.W. by N. of Ringland Church, and on the southern side of the plantation, the Chalk contained flints, and was soft and rubbly. The fossils from these two pits are noted in the list, p. 11.

Ringland.—In a pit just south of the church, and by the road, the following succession was clearly shown in 1883:—

Coarse gravel, in places; may possibly be Plateau Gravel.

Glacial Drift. { Well-stratified buff and brown sand, about 10 feet.
Brown stony loam, with a few fragments of shells. At the base, in places, irregular patches of grey clay and loam, with pebbles, marly patches, and chalky layers; 6 feet or more; the junction with the underlying sand marked and even.

Pebbly Series.—Sand with pebbles, finely stratified.

Chalk, with flints of very irregular shape (suitable for rock-work) in various places, but apparently not in planes of bedding. The only fossil got was *Serpula plexa*.

It seems as if this side-valley, like the main valley of the Wensum, had been partially cut out of the Chalk before the deposition of the Pebbly sand, which was horizontal in the above section, and abutted against a steep slope of Chalk, whilst the stony loam rested directly on the higher part of the Chalk, without the intervention of the Pebbly Series, with the exception of a few seams, together from about 3 to 6 inches thick, of orange-coloured and ash-coloured pebbly sand, in which were a few impersistent layers of marl or chalk, from half an inch to 2 inches thick.

Soft rubbly chalk with flints was exposed in a pit three eighths of a mile E.N.E. of Ringland Church.

In a chalk-pit a quarter of a mile N.N.E. of Ringland Church, about 18 feet of chalk, containing irregular-shaped flints, was exposed. There was only a covering of soil, from about a foot to 1½ feet in thickness. From 3 to 6 feet down there occurred four festoons of flints, the length of each varying from about 20 to 30 feet, showing apparently a disturbance of the Chalk from above.

In a pit five eighths of a mile S. of Ringland Church, and at another pit a mile S.S.E. of the church, both on the sloping ground west of the River Wensum, the Chalk was soft and rubbly, and contained flints.

The fossils noted in the list, p. 11, are chiefly from the fourth, but partly also from the rest (except the fifth) of these Ringland sections.

Elsing and Worthing.—Sections at these places are described on pp. 20, 25.

Western and Southern Tracts.

Litcham.—"The Chalk is well shown in the pit by the cross-roads a short distance N.E. of the church, where it is burnt for lime and manufactured into whitening, while the flints are broken up for road-metal. In about 25 feet of chalk five or six layers of black flint nodules and a few large irregular-shaped flints were seen. The chalk here is harder than that at Norwich, and contains manganese-ore in crevices. The names of the few species of fossils obtained (in the summer of 1883) have been included with the longer list by Mr. C. B. ROSE (p. 11)."

"A little further north-east is another lime-kiln, now disused. Here the Chalk is somewhat disturbed, and is overlain by 5 or 6 feet of gravelly soil and marl. No doubt this is the pit referred to by Mr. ROSE, who observed that 'At Litcham the layers of flint are placed from four to six feet asunder; their horizontal course is not a plane, but slightly undulating: at the depth of twenty feet a double row occurs, the two layers being about nine inches asunder.*' The same section (probably) has been described by Mr. S. V. WOOD,

* *Phil. Mag.*, ser. 3, vol. vii., p. 190 (1835).

jun.,* at the time of whose visit a very striking disturbance in the Chalk had been opened up. This had evidently been produced from the surface, and in Mr. Wood's opinion by Glacial action."†

Kempstone.—About 20 feet in thickness of Chalk was exposed in the pit a little more than half a mile S.S.W. of Litcham Church: in places, the Chalk extended to the surface of the ground, but in other parts it was overlaid by a brown sandy and loamy soil from 1 to 2 feet thick. The Chalk was yellowish, contained flints, and yielded the fossils named in the list below.

Great Dunham.—In a pit a mile N. of the church, and a little more than a quarter of a mile S.E. of Lexham Plantation, soft and rubbly chalk with flints was exposed, and yielded *Coscinopora*, sp., *Ostrea vesicularis* (fragments), and *Inoceramus Brongniarti*.

Ashill.—"Three quarters of a mile west of the church is a large pit showing 30 feet of rubbly chalk, bedded with bands of nodular flint. From here came the fossils in the list below."

Carlton Forehoe.—"At Four Hill Wood, half a mile S.W. of the church, there is a pit showing Boulder Clay, resting on rubbly yellowish chalk with flints, 12 feet thick, from which the fossils named in the list below were obtained."

Great Melton.—"Three eighths of a mile S.E. of Marlingford Church, a pit showed sand resting on soft rubbly chalk with flints."

"At Algarsthorpe soft rubbly chalk is dug for burning into lime, and may be seen in the pit east of the farm. At both of these pits fossils were got, see below."

Easton.—"Eastward of Easton Lodge is a pit showing about 12 feet of rubbly chalk. Half a mile west chalk is again seen, capped by sand. Three quarters of a mile further west is another pit showing rubbly chalk.‡

Baugh.—At the chalk-pit nearly a quarter of a mile N.W. by N. of the church, flints occurred in soft rubbly chalk, from which latter were obtained *Coscinopora*, *Rhynchonella plicatilis*, and *Belemnitella quadrata*.

Beeston.—The section here is described on p. 34.

LIST OF FOSSILS.

With the exception of those from one locality, the fossils from which the following list has been made were collected by the Geological Survey, and determined by Mr. G. SHARMAN and Mr. E. T. NEWTON. The exception is the most prolific locality, Litcham, the list for which has been compiled by Mr. H. B. WOODWARD, chiefly from that given by Mr. C. B. ROSE in 1835 (*Phil. Mag.*, ser. 3, vol. vii., p. 278), and partly from that by Mr. S. WOODWARD, in his "Geology of Norfolk," page 50, the few species collected by himself being also noted. The nomenclature has been revised by Messrs. SHARMAN and NEWTON; but the names given in the two old Norfolk lists are added, in brackets.

The localities are shown by letters, as follows, except in three cases of almost isolated occurrence, in which the names are given:—

a = Ashill.	h = Litcham.
b = Attlebridge (3 pits).	i = Lyng (2 pits).
c = Billingford (2 pits).	j = Morton (2 pits).
d = Carlton Forehoe.	k = Ringland (3 pits).
e = Great Melton (2 pits).	l = Sparham (4 pits).
f = Great Witchingham (5 pits).	m = Swannington.
g = Kempstone.	n = Taverham.

Some few occurrences, of two or three species only, are noted in the text.

* *Quart. Journ. Geol. Soc.*, vol. xxiii., p. 84 (1867); and *Geol. Mag.* 1887, p. 486.

† From Mr. H. B. WOODWARD's notes. See also *Geol. Survey Memoir* on the country around Norwich, p. 136.

‡ From Mr. F. J. BENNETT's notes.

Fish.

Oxyrhina Mantelli, *Ag.* (*Squalus zygæna*), h.

Cephalopoda.

Ammonites, fragment, h.

Belemnitella mucronata, *Schlt.*, h.

„ *plena*, *Blainv.*, l (doubtful).

„ *quadrata*, *Defr.* (*B. granulatus*), b, c, d, f, h, i, j, k, l, m, n.

„ sp., i.

Gasteropod.

Pleurotomaria perspectiva, *Mant.* (*Cirrus*), h.

Lamellibranchiata.

Avicula, sp., i.

Exogyra, sp., l.

Inoceramus Brongniarti, *Sby.*, a, h.

„ *Cuvieri*, *Sby.*, h.

„ *involutus*, *Sby.*, h.

„ *Lamarckii*, *Park.* fragments, h.

„ sp., c, d, f, g, i, l, n.

Lima Hoperi, *Sby.* (*Plagiostoma*), h.

Ostrea acutirostris, *Nills.*, c.

„ *semitransversalis*, *Mant.* (*O. alæformis*), h.

„ *vesicularis*, *Lam.*, e, j.

Pecten nitidus, *Mant.*, b, h, i?, m.

Spondylus (*Dianchora*) *latus*, *Sby.*, h.

„ sp., f, n.

Brachiopoda.

Crania parisiensis, *Defr.*, h.

Kingena lima, *Defr.*, l.

Rhynchonella Cuvieri, *D'Orb.*, h.

„ *limbata*, *Schlot.*, k.

„ *plicatilis*, *Sby.*, Bauburgh.

„ sp., i, n.

Terebratula semiglobosa, *Sby.* (*T. subrotunda*), b, g, h, k.

„ sp., e, j.

Terebratulina gracilis, *Schlot.*, j, m.

„ *striata*, *Wahl.*, i.

Polyzoa.

Alecto ramea?, *Blainv.*, m, n.

„ sp., i.

Ceripora polymorpha, *Goldf.* (*Millepora*), h.

Diastopora, sp., b, e.

Flustra utricularis, *König*, h.

Hippothoa, sp., g.

Idmonea?, *truncata*, *Blainv.* (*Millepora*), h.

„ sp., Swanton Morley.

Lunulites, sp., e.

Membranipora, sp., d, f, k.

Mollia, sp., m.

Tubulipora, sp., a, e.

Polyzoon, k.

Annelida.

Serpula fluctuata, *Sby.*, h.

„ *granulata*, *Sby.*, h.

„ *plexa*, *Sby.*, e, h, j, k.

„ *spirulæa*, *Sby.*, h.

„ sp., d, j, k, m.

Vermicularia, sp., a, g.

Vermilia ampullacea, *Sby.*, h.

Echinodermata.

Bourgeticerinus ellipticus, *Miller* (*Apiocrinites*), h.

„ ^{sp., g.}
Cidaris sceptrifera, *Mant.* (*C. cretosa*), h.

„ ^{sp., a, g.}
Cyphosoma corollare, *Klein* (*Echinus saxatilis*), h.

Echinocoonus conicus, *Breyn.* (= *Galerites albogalerus*), h.

Echinocorys vulgaris, *Breyn.* (*Ananchytes hemisphaericus* and *scutatus* =
A. ovatus), b, d, e, f, h, i, k, l, m.

Goniaster Mantelli, *Forbes* (*Asterias semilunatus*), h.

Holaster planus, *Mant.*, h.

„ ^{sp., b.}
Infulaster excentricus, *Rose* (*Cardiaster* or *Spatangus*), h.

„ ^{rostratus}, *Forbes* (*Cardiaster*),* h.

Micraster coranguinum, *Klein*, g, h, l.

„ ^{sp., e.}
Oreaster pistiliferus, *Forbes*, c.

Echinoderm spine or plate, d, f.

Coral.

Parasmilia centralis, *Mant.* (*Caryophyllia*), a, h, k, l, n.

Hydrocorallina.

Porosphaera (*Coscinopora*) *globularis*, *D'Orb.* (*Millepora*), b, e, f, h,

„ „ ^{sp., f, l.}

Spongida.

Spongia, sp., a, c, d.

Ventriculites infundibuliformis, *Woodw.*, k.

„ (*Coscinopora*) *quincuncialis*, *Smith*, a.

„ *radiatus*, *Mant.*, h.

„ ^{sp., d, f, i, j, k, l, n.}

* Mr. ROSE had only two specimens of this in his collection.—*Geol. Mag.*, vol. v., p. 30.

CHAPTER III. PEBBLY SERIES.

GENERAL REMARKS.

No Tertiary beds are known to exist in this district between the Chalk and the Drift, unless this Pebbly Gravel and Sand is included with the Pliocene deposits.

The age, position, or geological horizon of this formation, is well shown in many sections in the Norwich district, and in other localities, where these pebbly beds are exposed, sometimes reposing upon an eroded surface of the Chillesford Clay, and underlying the Lower Glacial Stony Loam, or Lower Boulder Clay.

There is, however, some difference of opinion with respect to the nomenclature, classification, and correlation of these Pebbly beds, which were first brought to the notice of geologists, in 1866, by Mr. S. V. WOOD, junior, under the name of "Bure Valley Beds";* and afterwards conjointly described by him and Mr. F. W. HARMER, under the term "Pebbly Sand and Pebble Beds." These authors expressed their opinion that if a local name were desirable, none could be so proper as that of "Bure Valley Beds," both by reason of its priority, and of the fact that their greatest exposure (where fossiliferous), &c., occurs in the valleys of the Bure and of its tributaries.†

Prof. PRESTWICH afterwards described some of these beds under the term of "the Westleton Sands and Shingle,"‡ and for the most part I agree with his correlations, but not with the essential reason for his nomenclature at Westleton.

Mr. H. B. WOODWARD groups the fossiliferous Bure Valley Beds with the Weybourn Crag, and therefore includes these Pebbly Gravels and Sands with the Pliocene, classifying them as the uppermost division of his "Upper Crag" or "Norwich Crag Series."§

Mr. C. REID, remarking that the "typical Bure Valley fauna occurs below and not above the Forest-bed," has described the fossiliferous sands that overlie the Forest-bed on the Norfolk coast under the name "Leda Myalis Bed," considering that their "exact relation to the Crag and to the Glacial Beds is still an open question"; and also, that these upper beds on the coast have "erroneously been correlated with the Bure Valley Beds," an opinion which I do not share.||

* See *Quart. Journ. Geol. Soc.*, vol. xxii., p. 546 (1866).

† See Supplement to the Crag Mollusca, pp. 15, 16, *Palaontograph. Soc.*

‡ See *Quart. Journ. Geol. Soc.*, vol. xxvii., p. 461 (1871).

§ See *Geol. Survey Memoir on the country around Norwich*, by H. B. WOODWARD, p. 31; also his *Geology of England and Wales*, ed. 2, pp. 469, 470 (1887).

|| See *Geol. Survey Memoir on the country around Cromer*, by C. REID, pp. 9, 46.

Although the subject is an important one, it would be foreign to the purpose of this memoir (which refers to a small area) to enter upon a discussion as to the merits of the various opinions held by those who have studied the beds. With regard to my own, they agree in the main with those first promulgated by Messrs. Wood and Harmer, but I consider that these authors made some errors in correlation, and one in particular, which has caused much confusion respecting the palæontological evidence, namely, in their correlating the Weybourn Crag (Norwich Crag) with these Pebbly or Bure Valley Beds. I adhere to the views expressed in my address to the Norwich Geological Society,* and prefer to regard these Pebbly beds as representing the commencement of the Drift period, rather than to include them with the Crag or Pliocene, to which, in my opinion, they are unconformable.

[On the Maps, and in the Memoirs on the Scuthwold and Halesworth districts, the Pebbly Series has been left unbracketted, either with Drift above or with Crag below. W. W.]

In this district there are some good sections of these Pebbly beds in the neighbourhood of the Wensum Valley, at Whitwell, Alderford, Attlebridge, and Ringland; and also in places extending a little further south to Banburgh Hangings. The beds are generally from about 10 to 15 feet in thickness, and consist of black flint and white quartz pebbles intermixed in various proportions with buff, orange-coloured, and ash-coloured sand. They are well stratified in places, sometimes false-bedded, and contain seams and lenticular patches of grey clay and marl. They are also frequently ferruginous, particularly in the lower part, and are sometimes more or less indurated. In places, as at Alderford Common, the formation consists almost entirely of pebbles, resembling well-rolled beach-shingle; elsewhere the sand often predominates. In a few localities the pebbles occur in a matrix of marl. No fossils, so far as I know, have been found in this formation in our area.

LOCAL DETAILS.

Whitwell.—During the construction of the Eastern and Midlands Railway, good sections were exposed in the road-cuttings in the neighbourhood of Whitwell Station, showing pebbly sands resting on Chalk and overlaid by Lower Glacial stony loam. In the road-cutting on the western side of the railway, about a quarter of a mile S. of the station, and a mile and a quarter S.W. by S. of Reepham Church, from 7 to 10 feet of ash-coloured sand, containing black flint and quartz pebbles, immediately overlaid the Chalk. There was a little brown loam and ferruginous sand interstratified in the upper part of the sand. This was overlaid by stony brown loam, there being a very even and marked line at the junction of the pebbly sands with the loam. The Chalk was exposed to a depth of 10 to 14 feet, was very soft, contained much water, and had many flints irregularly occurring throughout. Its top-surface was very irregular, pinnacles (as it were) of chalk penetrating into the overlying pebbly sand.

These pebbly sands were well shown in the road-cutting on the eastern side of the railway, leading to the small bridge under the railway, about a quarter of a mile S. of Whitwell railway-station. Here from 10 to 15 feet in thick-

* "On the Age and Relation of the so-called 'Forest Bed' of the Norfolk and Suffolk Coast," *Proc. Norwich Geol. Soc.*, pt. v., pp. 137-160 (1881).

ness of light-brown and orange-coloured sands was exposed, containing numerous black flint and quartz pebbles. In places the sands were ash-coloured. Some marl, or worked-up chalk, overlaid in places the true Chalk, which latter showed a very irregular surface. There were also a few patches of marl in the pebbly sands.

In the road-cutting N. of Whitwell railway-station there was a good section which showed pebbly sand resting on Chalk and underlying Lower Glacial loam. The pebbly sand was about 10 feet thick, brown and ash-coloured, and contained numerous quartz and black flint pebbles. There was a little loam in places in it; but a sharp and most conspicuous line at the junction with the overlying stony loam, a considerable thickness of which latter was well exposed in fine sections during the excavation of the station-yard and its approaches.

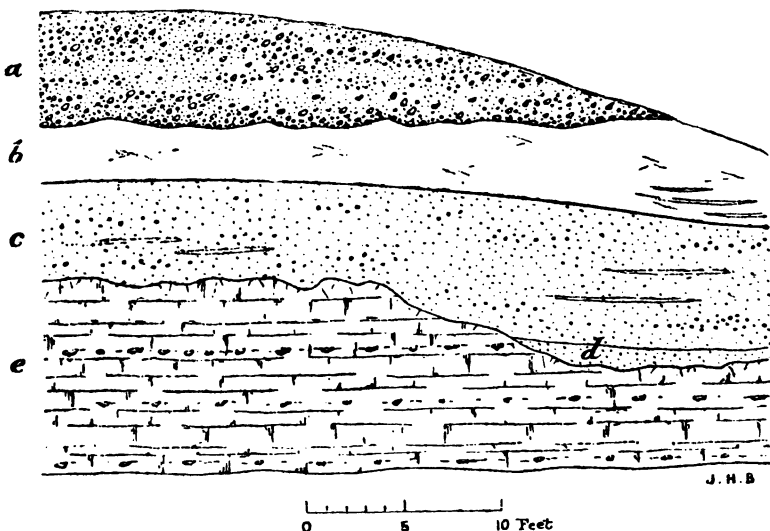
Alderford.—The following note, made by SAMUEL WOODWARD in 1830, is contributed by Mr. H. B. WOODWARD:—"Went to Lenwade Bridge, but could find no bank of Crag shells, as described to me by Mr. Jno. Addey Repton." A section here has been described above, p. 7.

Ringland.—In a pit on the eastern side of the church, a section showed 6 feet or more of brown stony loam, overlaid by about 5 feet of brown gravel and sand, both beds of Glacial age. On the opposite side the loam rested on very pebbly greenish-grey loam and ash-coloured sand, beneath which were buff and orange-coloured sands. The Pebbly beds were about 9 feet thick, and ferruginous at their base, their junction with the overlying loam being very marked and even.

In the pit a few yards west of the above was the section shown in Fig. 4, and another section here is described above, p. 10.

FIG. 4.

Section in a Pit just S.W. of Ringland Church.



- | | | |
|----------------|---|--|
| Glacial Drift. | { | a. Gravel and buff sand. |
| | | b. Brown stony loam, weathering whitish-grey, with impersistent seams of marl and chalky material, from half an inch to 7 inches thick; 3 to 6 feet. |
| Pebbly Series. | { | c. Ash-coloured coarse pebbly sand, mostly more or less hardened, with a few lenticular patches of grey clay; 5 to 8½ feet. |
| | | d. Orange and buff sand, ferruginous in places, in an irregular hollow; 1½ feet. |
| | | e. Chalk, with an irregular upper surface; 10 feet. |

Costessy (in 66, N.E.) and *Bauburgh*.—"Owing to the steep slope and absence of sections, it is difficult to say how far the Pebbly beds (probably the upper part of the Norwich Crag Series) extend westwards below Lords Hill, and again north-west of Costessy Park and by the Bauburgh Hangings."

"A pit by the junction of the roads, south-west of Bauburgh Hangings, showed traces of pebbly sand and micaceous laminated clay resting directly on the Chalk; above this were patches of Boulder Clay, and on the top sand and gravel. Further west the Boulder Clay comes directly over the Chalk."

Marlingford.—"S.E. of Beck Common a pit was opened in pebbly gravel resting on chalk (?). The gravel contained much quartz and quartzite, as well as flint-pebbles."*

Sections at Billington, Attlebridge, Sparham, Great Witchingham, Swannington, and Lyng are described on pp. 5, 6, 7, 9.

* From Mr. H. B. WOODWARD's notes.

CHAPTER IV. GLACIAL DRIFT.

LOAM WITH BOULDERS (LOWER BOULDER CLAY).

General Remarks.

This deposit is of the same age and similar in character to the stony loam in the neighbourhood of Norwich, in the cliffs on the Suffolk coast at Corton, around Martham and Ormesby Broad (north of Yarmouth), on the Cromer coast, and in several other localities.

Its usual character is that of an unstratified brown or reddish-brown stony loam, sometimes mottled with grey. There are occasionally patches or streaks of marl and chalky clay; and also more or less circular and oval masses or nests of white and buff sand, called "sand-galls." On the low ground north and west of Billingford Heath this formation becomes very chalky.

Fragments of marine shells occur more or less sparsely scattered throughout, and also in the included nests of sand, in numerous localities in the Wensum Valley (*see* Local Details below), in a similar manner as on the coast at Corton and elsewhere, fragments of *Tellina balthica*, *Cardium edule*, *Cyprina islandica*, and *Mya arenaria*, being perhaps most abundant or most easily recognisable; the fragmentary and sometimes decorticated condition of the shells presenting difficulties with respect to their identification. Messrs WOOD and HARMER have recorded the finding of the femur of a small mammal in this loam at Elsing;* it is very seldom, however, that any mammalian remains are met with.

Huge striated boulders or erratics, derived from Palæozoic and igneous rocks, occur here and there scattered throughout, but so sparingly that often not a single boulder is to be seen in a section. They are occasionally met with, however, in the country where this Loam occurs, on the road-side, against farm-buildings, having been removed from the ploughed fields.

The base of this formation throughout the district almost invariably presents a sharp and even, but sometimes slightly undulating line, at its junction with the Pebbly Series or other underlying deposit on which it reposes. The top part of the formation, on the contrary, almost as invariably presents a very irregular line, with clear evidence, in some sections, of a certain amount of denudation having taken place before the deposition of the overlying Sand and Gravel. The sections exhibited in the

* See Supplement to Crag Mollusca, p. 20, *Palæontograph. Soc.* (1872).

pits in the Wensum Valley are the precise counterpart of what is to be seen in the cliffs on the Suffolk coast at Corton.*

The deposit, as seen in the pit-sections, varies in thickness from about 9 to 18 feet or more, but in the East Dereham boring was proved to be 26 feet (see p. 54).

Local Details (Northern Side of the Wensum Valley).

Billingsford.—Marly loam and clay, about 12 feet in thickness, was shown in two pits a mile W.N.W. of the church, adjoining the marshes and close to the river. The deposit was greyish, weathered yellowish-white on the surface, and contained a large quantity of chalk. Three "pipes" occurred in one of the pits, each being about 3 feet in length, and filled with chocolate-brown clay, a little of which latter overlaid the marl in places.

Foxley.—Nearly three quarters of a mile E.N.E. of Billingsford Church a pit adjoining the road, on the southern side of the plantation E. of Beck Hall, gave the following section :—

	Feet.
Glacial { Brown and buff sand, with a little gravel (Middle Glacial) - - - - -	10 to 15
Drift. { Loam, stony, brown, mottled with grey, and containing fragments of marine shells -	10 +

The fragments of shells were mostly friable and difficult to identify, as is frequently the case in this formation. Some whole shells, however, are sometimes to be observed; in this pit in the loam, two whole *Tellinæ* were found, and a large fragment of a *Cardium*. The stony loam was well shown in section on the lower part of the slope, and had not been bottomed, so the total thickness was not exposed. The overlying sand was capped on the high ground by Boulder Clay, 15 feet of which was exposed in a pit a quarter of a mile N.E. of this corner of the plantation. Thus an Upper and Lower Boulder Clay, with a considerable thickness of intervening sand (the amount shown in this pit not representing the total thickness), clearly exists in this locality.

Bylaugh.—The following section was exposed in a pit a little more than one mile S.E. by S. of Billingsford Church, on the western side of Bylaugh Park, adjoining the alluvial land. In one part of the pit the loam rested directly on the marl, without the intervention of the orange- and ash-coloured sand.

	Feet;
Middle { Sand and gravel - - - - -	2
Glacial. { Loamy sand, more or less indurated - - - - -	2 to 4
{ Sand, brown and orange-coloured - - - - -	6
{ Gravel - - - - -	$\frac{1}{2}$
Lower { Loam and clay, grey, stony, chalky, and more Glacial. or less indurated, with a marly or chalky seam, 4 inches thick, at its base - - - - -	6
{ Sand, orange- and ash-coloured, with some large flints - - - - -	2
{ Marl (or re-deposited chalk, with a very ir- regular surface) - - - - -	9
Chalk - - - - -	?

A larger pit occurs a few yards to the N. of the above, but owing to talus and vegetation, a clean section from top to bottom was not exposed. About 5 feet in depth of white chalk was shown at the base of the pit, on which rested stony chalky clay or marl, somewhat similar to that in the adjoining pit; then some brown sand overlaid by more or less mottled reddish-brown loam, apparently 7 or 8 feet thick or more, the upper portion having some patches of yellowish-white marl in it, and above this a considerable thickness of brown sand and gravel, from 9 to 10 feet of which was exposed.

* See Geological Survey, Horizontal Section, Sheet 128.

Two loam pits occur, adjoining one another, half a mile S.E. of Bylaugh Church, close to the river and south of the Old Hall. In the pit in the field on the eastern side of the road, 6 feet of grey loam (not bottomed) was shown underlying 3 feet of buff sand. The top part of the loam had a very uneven surface, and the junction with the overlying sand showed a very irregular line. A little chalky clay was exposed in one part of the pit at the base of the loam. Yellowish-white bricks were made from some of the grey loam for the new wall on the western side of the road leading down to the marshes north of Elsing Mill.

At an old pit on the sloping ground, a quarter of a mile E.S.E. of Bylaugh Church, there appeared to be about 10 to 15 feet of stratified sand, underlaid by about the same, or by a greater thickness of loam, the upper part of which was yellowish, and very fine in texture, but owing to the pit being much overgrown in places with grass, the junctions were not clearly shown. An excavation in the lower part showed 3 feet of chalk, at a spot about level with the adjoining marsh-land; possibly chalk may occur at a higher level in the pit, but this could not be seen, on account of the sides being obscured.

Sparham.—In a pit about 40 yards west of that a mile west of Lenwade Bridge (see p. 6), the thickness of the loam was shown to vary from 12 to 18 feet. A boulder of grit, exposed in the loam, measured $2\frac{1}{2}$ by $1\frac{1}{2}$ by 1 feet, and was much striated on one side. Numerous fragments of marine shells occurred in the loam, which latter weathered from brown to yellowish-white. Other sections here are noticed on pp. 24, 47.

Whitwell.—A fine section was exposed during the excavation of the railway station-yard. The stony loam was about 17 feet in thickness, and reddish-brown, but greyish and chalky for a few feet in depth at the base in places; there were several patches of white and buff sand in it, some of them containing gravel and fragments of marine shells (*Cardium edule*, *Tellina balthica*, &c.). Fragments of marine shells were also interspersed throughout the loam.

Great Witchingham.—In a loam-pit three quarters of a mile S.S.E. of Reepham Church, on the eastern side of the valley, from 10 to 15 feet of brown stony loam was exposed. It contained fragments of marine shells sparsely scattered throughout, together with several small patches of light-buff sand, containing numerous fragments of shells. The upper 3 feet of the loam was very chalky, and irregularly overlaid with brown loam.

Attlebridge.—In a pit half a mile E.S.E. of the church, from 14 to 16 feet of very chalky loam and clay was exposed. The uppermost portion contained so much chalk that it had a marly appearance, and very chalky brown and grey loam occurred beneath, underlaid by 3 or 4 feet or more of dark grey (almost black) clay with pebbles of chalk. Some portions of this clay, particularly the lowermost, much resembled the Upper Boulder Clay.

Local Details (Southern side of the Wensum Valley).

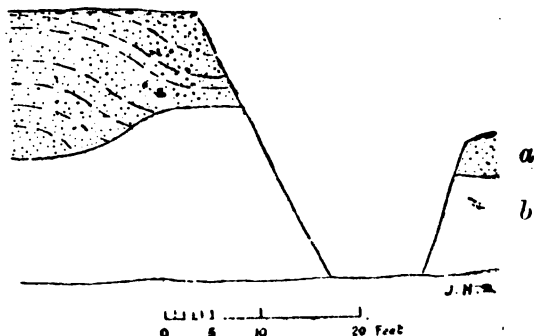
Swanton Morley.—On the sloping ground a few yards N.E. of the church, an old pit, much overgrown, showed loam overlaid by sand, which latter was capped on the high ground by Boulder Clay.

Elsing.—An interesting section (as in Fig. 5) showing sand resting unconformably on stony loam, was exposed in a pit half a mile N.W. by W. of the church, on the northern side of the road, on the sloping ground. The sand was contorted and dipped down at a considerable angle towards the irregularly curved surface of the loam, the junction being sharp. The top part of the loam presented as irregular an appearance as some of that (of the same age and character) in the cliffs on the coast at Corton, between Yarmouth and Lowestoft.*

* See Geological Survey Horizontal Section, Sheet 128.

FIG. 5.

Section in a Pit N.W. by W. of Elsing Church.



- a. Stratified and contorted whitish and buff sand with reddish-brown bands in the upper part, and in places a few thin seams and patches of fine gravel (pebbly and subangular); in the lower part a little carbonaceous matter (Middle Glacial); 12 to 15 feet.
- b. Reddish-brown unstratified stony loam, with many small pebbles and subangular flints irregularly scattered throughout the lower part, marly, more or less indurated, and with some fragments of marine shells; 18 feet.

In another pit a quarter of a mile W. of the above, on the sloping ground S.E. of the farm-buildings, greyish stony loam was exposed overlying some marl or re-constructed chalk, resting on genuine chalk. On account of the pit being much overgrown, the junctions were not clearly shown.

In the yard south of Elsing Mill, nearly three quarters of a mile N. of the church, there was a good section showing from 15 to 18 feet of loam resting on chalk. The lower 9 feet was stony and brown; the upper part contained some chalky clay or marl, with a patch of brown sand underlying it on the western side. The loam rested on an irregular surface of the Chalk; which latter was exposed to a depth of 6 feet, and contained irregular-shaped black flints.

Lyng.—From 11 to 12 feet of reddish-brown stony loam was exposed in a pit about a quarter of a mile E. of Walnut Tree Farm, on the northern side of the road. The loam was rather sandy in places, and contained flint and quartz pebbles.

At another pit about 200 yards E. of Walnut Tree Farm, on the southern side of the road, whitish and grey chalky marl, with chalky seams and bands, was exposed. The lower part contained numerous pebbles of quartz and flint, apparently derived from the Pebbly Series. This marl was at a little lower level than the loam in the pit described above. Another section here has been described on p. 9.

Weston.—In a pit half a mile E.S.E. of Lenwade Bridge, on the southern side of the road, from 15 to 18 feet in thickness of brown and buff loam was exposed, with marly patches and chalky streaks in places. Some of the loam was stratified and in thin beds on the western side, and was stiff.

Ringland.—The sections here are given on pp. 10, 16.

Local Details (Southern Tract).

Ashill.—"On the high ground half a mile south-west of the church, brick-earth is dug in one or two places showing 8 feet of rather stiff brown and grey clay resting irregularly on chalk."

Carlton Forehoe.—"At the southern end of Four Hill Wood the south part of a large much overgrown pit shows Boulder Clay resting on brown and grey sandy loam, together having a thickness of 15 feet."* This loam could not be shown on the map, for it seems not to come to the surface.

* From Mr. F. J. BENNETT's Notes.

CHAPTER V. GLACIAL DRIFT (*continued*).

SAND AND GRAVEL (MIDDLE GLACIAL OF WOOD).

General Remarks.

This division consists for the most part of well-stratified buff sand, whitish in places, and occasionally containing reddish-brown, more or less ferruginous, sandy and loamy bands. It is false-bedded in places, and is similar in general character to the deposit of the same age in the fine cliff-sections on the coast at Gorleston and Corton, S. of Yarmouth; and at Kessingland and Pakefield, S. of Lowestoft. It varies somewhat in composition in different localities, being almost entirely sand in some places, whereas in others there are seams and lenticular patches of gravel in the sand, and sometimes large masses of gravel, particularly in the upper part, coarse, but generally much water-worn (see p. 55, Dereham boring). Some grey, brown, and buff loam is occasionally interstratified with the sand, particularly in the upper part; and where the sand is whitish, numerous grains and pebbles of chalk are often to be observed, and in some places, little specks of carbonaceous matter.

Fragments of marine shells, which are very plentiful in this division in many localities near Yarmouth and Lowestoft,* at Cromer and elsewhere, have only been observed in a few places in this district, namely, in the neighbourhood of Reepham, at Hackford, Whitwell, Brandiston, &c.; and near Hoe, N. of East Dereham.

Occasionally masses of sand, immediately underlying or near the base of the Boulder Clay, are more or less indurated, apparently from the infiltration of carbonate of lime from the Boulder Clay; and when seen on the steep slopes of a valley, these jut out from their face in an irregular and rock-like condition, owing to the unequal resistance offered by the soft and by the hard cemented portions of the sand to subaerial denudation.

The sections of this sand and gravel in this district show a thickness of about 15 to 30 feet; but these sections do not show both the upper and lower junctions with the Boulder Clays, therefore the figures mentioned do not represent the total thickness of the sand and gravel. At East Dereham, the waterworks-boring proved this division to be 69 feet thick (see p. 55).

Local Details (North of the Wensum).

Billingford.—In a pit nearly three quarters of a mile S.E. of the church, on the slope of the escarpment and to the west of the plantation, about 9 feet of brown sand was shown, overlaid by gravel, and resting on buff unctuous loam.

Three quarters of a mile N.E. by N. of Worthing Church, a pit adjoining the marsh-land north-west of Grint Mill shows 7 feet of very light buff sand,

* See Geological Survey Memoir "On the Geology of the Country near Yarmouth and Lowestoft."

well stratified, and with a considerable south-easterly dip, which would bring down the overlying Boulder Clay to the level of the marshes, as shown in the clay-pits to the east. Some of the sand was whitish, and contained patches of chalky gravel. Another section here is shown in fig. 7, p. 42.

Foxley.—About 12 feet of buff sand was well exposed, extending down to the level of the adjoining Alluvium, in a pit in the plantation east of Beck Hall, and about 200 yards north of the section described on p. 19.

Bawdeswell.—Several pits occur on Bawdeswell Heath, where Plateau gravel is shown to rest on Glacial sand and gravel. In a pit about a mile W.S.W. of the church, fine buff sand, with some reddish-brown bands, had been excavated to a depth of 6 feet; this was overlain in places by a little loam, above which occurred a few feet of coarse Plateau gravel.

About 200 yards S.W. of the above pit, and just north of the obtuse angle in the road N.W. of Bylaugh Park, is another pit, where from 12 to 18 feet of very coarse flint-gravel was exposed, the upper portion containing much interstratified sand. Many of the flints were much rounded, others were more or less subangular; they were mostly from 3 to 6 inches in diameter, but a few were more than 12 inches. The stratification was horizontal.

A large sand-pit N. of Bylaugh Park, about 300 yards E. of the above pit, and at a higher level, gave a fine section, 18 feet deep, in well-stratified buff sand, containing reddish-brown bands, similar to the Glacial sand so well exposed along the coast S. of Gorleston. Unconformably overlying the sand, from 1 to 4 feet of unstratified coarse Plateau gravel, was well shown; which, on the summit of the Heath in places attained a thickness of 6 feet or more. Two flints, observed in this gravel, measured more than 18 inches in diameter. A marked ferruginous line was shown in places, at the junction of the coarse gravel with the underlying sand.

Bylaugh.—At a short distance from the section illustrated in Fig. 6, p. 32, and in the same pit, but at a little lower level, an excavation showed from 3 to 4 feet of light-grey and buff loam. About 30 yards west of this, and at about the same level, another excavation showed about 3 feet of grey and buff loam, whitish and somewhat indurated in places, underlaid by at least 4 feet of light-buff, more or less stratified sand. This loam, which becomes sandy in places, is evidently in the sands.

In Bylaugh Park, near the above pit, a little more than three quarters of a mile N.E. by E. of the church, and about 40 yards west of the road, a pit showed 7 feet of well-stratified buff sand, the bottom of which had not been reached.

About 6 feet of fine buff sand was exposed in a small excavation three quarters of a mile S.W. of Bawdeswell Church, a few yards south of the north wall of Bylaugh Park, and a little east of the northern entrance-gates.

At an old brickyard about three quarters of a mile N.E. by N. of Bylaugh Church, the following section was exposed in 1883, at the southern end of the yard:—

	Feet.
Plateau Drift ? { Reddish-brown loamy sand, more or less indurated, and containing numerous small angular and sub-angular fragments of flints ("Uncallow.*") This lay in an irregular or wavy manner on the next deposit - - - - -	6
Middle Glacial (?) { Reddish-brown stiff sandy loam, more or less indurated in places, and mottled with grey and blackish patches in the lower part - - - - -	3 to 5
{ Stratified yellow and buff sand with ferruginous or rusty and chocolate-coloured patches - - - - -	3
On the western side was the following section:—	
Plateau Drift (?)—Reddish-brown loamy sand, with numerous flints ("Uncallow.*") - - - - -	7 to 10
Middle Glacial (?) { Reddish-brown sandy loam - - - - -	3
{ Grey and brown loam and clay mottled with blackish patches in places - - - - -	7 to 12
{ Whitish and ash-coloured sand and gravel, underlaid by reddish-brown sand and gravel - - - - -	3 +

* Local term for waste, or material not used in brick-making, etc.

The top reddish-brown loamy sand may possibly be of the same age as the Plateau gravel, but the underlying grey and brown loam and clay may belong to the upper part of the Middle Glacial, rather than to the Lower Glacial.

The depth to the Chalk was 80 feet. (See well-section, p. 54.) If this is correct, it would favour the view expressed, the loam or brick-earth is of Middle Glacial age, and similar to that at Woolpit, in Suffolk, and elsewhere.

Another section at Bylaugh is noted on p. 19.

Sparham.—A pit half a mile S. by E. of the church, on the western side of the road, shows from 18 to 20 feet of well-stratified light-buff sand, false-bedded in places, and with only two or three thin lenticular seams of small subangular gravel.

Fine buff sand was exposed in a small pit on the sloping ground E. of Sparham Old Plantation. This sand overlies loam, as shown in a small pit a few yards S. of the above, and adjoining the small buildings on the eastern side of the road. The pit by the rifle-butt is described at p. 6.

Whitwell.—In a pit half a mile S.S.W. of Whitwell Hall, 6 feet of buff sand was exposed. At another sand-pit about 200 yards N.W., the sand overlies loam, which latter contains some chalky clay.

The section at a sand-pit nearly three quarters of a mile N.E. by N. of Sparham Church, on the sloping ground, showed 15 feet of very finely stratified buff and white sand, iron-stained in part, and much false-bedded, with a little grey loam interstratified in places, together with numerous grains and small pebbles of chalk. This sand is overlaid by Boulder Clay immediately to the north, where it has been excavated.

A section, showing a disturbance of the beds, was exposed in a sand-pit a mile and an eighth N.N.E. of Sparham Church, on the northern side of the road. The sand was brown, well stratified, but very much contorted on the northern side, where the bedding in one place was vertical for a thickness of at least 12 feet; whereas, about only 20 yards distant, on the eastern side, the bedding was nearly horizontal, merely having a slight undulating dip towards the north.

An account of another section will be found on p. 32.

Hackford.—In a pit five eighths of a mile S.W. by W. of Reepham Church, on the western side of the road, from 7 to 10 feet in thickness of buff and whitish sand was exposed, containing numerous fragments of marine shells.

Great Witchingham.—In a pit on the high ground three quarters of a mile W.N.W. of Lenwade Bridge, on the northern side of the road, 4 feet of sand (buff and orange-coloured, and containing numerous small pebbles of chalk and a little brown loam) was shown underlying from 7 to 10 feet in thickness of Boulder Clay.

Brown and buff sand was shown under 9 feet of Boulder Clay, in a pit half a mile S.E. of the church.

Little Witchingham.—Buff and yellow sand was exposed in a small pit half a mile E.N.E. of the church, on the southern side of the road S.E. of the Hall, overlaid by Boulder Clay, as shown near a pond about 200 yards to the east, and in other places.

Booton.—In a pit three quarters of a mile E. of Reepham Church, and W. of Booton Hall, 9 feet of buff sand was exposed, containing here and there seams and patches of fine subangular gravel.

Brandiston.—In a sand-pit over half a mile W.N.W. of the church, on the southern side of the road skirting the marsh-land, from 7 to 10 feet of buff and whitish sand was exposed.

At a large sand-pit a little more than half a mile N.W. of the church, south of the Common, on the sloping ground, the following section was exposed:—

Reddish-brown loam, with flints (the tailing-off of the Boulder Clay);
4½ feet.

Brown, white, ash- and orange-coloured sand, well stratified, and containing some small fragments of marine shells; 10 feet.

About half a mile S.W. of Brandiston Church, on the western side of the road and E. of Guton Hall, from 4 to 5 feet of brown sandy loam was shown in an excavation, overlying very light buff sand, the latter excavated to a depth of 5 feet. The loam was worked for brick-making, and was apparently in

the upper part of the Glacial Sands, near to the junction with the overlying Boulder Clay. Loam occurs in the upper part of the sands in a similar manner in the neighbourhood of Reepham and elsewhere.

Local Details (West and South of the Wensum).

Brisley.—Buff and reddish-brown sand was well exposed in a pit five eighths of a mile N.E. of East Bilney Church, on the sloping ground leading down to the Alluvium W. of Elmham Great Wood. Other sand-pits occur to the north and south. This sand evidently passes under the Boulder Clay exposed in pits on the high ground to the west, as it likewise does on the opposite side of the valley by Elmham Great Wood.

East Bilney.—A pit a little more than a quarter of a mile S.S.E. of the church, on the western side of the road and on the southern side of the valley, showed from 3 to 6 feet of unstratified coarse flint-gravel, uncomfortably overlying and overlapping fine buff stratified sand, excavated to a depth of 6 feet. The sand appeared to be slightly false-bedded in places, and, owing to the overlapping of the gravel, it is masked along the slope of the valley to the west.

On the sloping ground half a mile E. by N. of East Bilney Church, buff and reddish-brown sand was well exposed in a pit. Other pits occur to the north, on the same sloping ground, in a similar kind of sand.

Worthing.—A gravel-pit seven eighths of a mile E. by S. of the church, on the sloping ground S. of the river, exposed from 18 to 20 feet of very coarse and much water-worn flint-gravel with patches of orange-coloured and buff stratified sand in places. The gravel showed no sign of stratification, but presented a contorted or disturbed appearance. In the middle of it there was a patch of chalky clay (very much like Boulder Clay) containing a large flint. This clay was an irregular pear-shaped mass, 14 feet in length, 4 feet in thickness at the most, and 1 foot 6 inches at the least, and was surrounded by a little chocolate-coloured clay, from 3 to 6 inches thick. Another small patch of similar clay occurred in the gravel on the eastern side, and was almost vertical, the portion exposed being 5 feet in length and 1 foot in width, and similarly surrounded with a little chocolate-coloured clay. Several of the flints in the gravel were large, one being a "paramoudra."

In another pit a short distance to the E., about 24 feet of gravel and sand, more or less interstratified in places, was exposed. The gravel was not so coarse as that last described, and occurred chiefly at the upper part. On the western side, from 10 to 12 feet of gravel overlaid 12 feet of well-stratified orange-coloured and buff sand, which was not bottomed, and dipped towards the S., away from the valley. On the eastern side of the pit there appeared to be more sand. The section showed 3 feet of coarse gravel on the top, and a band of coarse gravel, 3 feet or more thick, interstratified with the sand, in the middle of the latter, about 12 feet or more from the top of the pit, and dipping to the S., away from the valley, as on the western side.

Elsing.—In a pit five eighths of a mile S.W. by W. of the church, on the western side of the road and north-east of Elsing Hall, 8 feet or more of buff sand was exposed underlying 6 feet of reddish-brown loam, containing flints and some patches of unaltered Boulder Clay. The pit is on the slope of the valley; and the loam overlying the sand is evidently the tailing-off of the Boulder Clay that occurs on the adjoining high ground, as well as at a lower level. Accounts of other Elsing sections will be found on pp. 20, 36.

Hoe.—The section here is described on p. 35.

Lyng.—A large pit a little more than half a mile W.S.W. of the church, on the western side of the fork in the road, gave the following section:—

Coarse reddish-brown flint gravel in a matrix of brown sand; 10 to 12 feet.

Sand, buff, containing reddish-brown bands; 6 feet.

About 15 feet of well-stratified buff sand was exposed in the road-cutting three quarters of a mile S.E. by E. of Lyng Church. In the upper 9 feet there were numerous grains and pebbles of chalk intermixed. The sand was overlaid by Boulder Clay on the higher ground just south.

The junction of the Boulder Clay with the underlying sand was well shown in a small pit on the western slope of the hill, about 200 yards south of the above road-cutting, and on the eastern side of the private road. Here, as occasionally in other localities and under similar conditions, the sand immediately underlying the Boulder Clay was indurated, and beds of it, together 3 feet in thickness, conspicuously jutted out from the sloping ground.

In a sand-pit on the sloping ground south of Walnut Tree Farm, on the western side of the road, and nearly seven eighths of a mile S.W. of Lenwade Bridge, 18 feet of stratified buff and whitish sand was exposed, containing numerous chalk grains and small pebbles of chalk, much false-bedded in places, and generally resembling the Glacial sands in the neighbourhood of Lowestoft and Beccles. Another Lyng section is described on p. 9.

Weston.—About 18 feet of buff and whitish sand was exposed in a pit adjoining the Alluvium, nearly a mile S.W. of Weston Old Hall, and three eighths of a mile W.N.W. of Grovewell Barn.

In another pit, nearly half a mile N.E. by E. of the above, and a little more than three eighths of a mile E.S.E. of Walnut Tree Farm, on the southern side of the road, from 18 to 20 feet of buff sand was shown.

Morton.—The following section was shown in a pit in the wood on the western side of the road, three eighths of a mile N.E. by N. of Weston Church:—

	Feet.
Sand, stony and reddish-brown - - - -	2
Coarse flint gravel - - - -	1½ to 2
Sand, well-stratified and false-bedded in places, buff and orange-coloured - - - -	6

Swannington.—Mr. H. B. WOODWARD notes that "East of Joles Farm, a pit was opened in buff sand."

Easton.—"Half a mile north of the church, on the steep side of the valley, is a section in a river-cliff, showing 20 feet of buff and yellow sand, with two lenticular patches of Boulder Clay, the lower of which contained a small boulder of grey granite."

"A little east of this last another section in the river-cliff showed the following succession:—

A little chalky Boulder Clay in thin patches	} 12 feet."
Brown and bluish sandy loam - - - -	
Ferruginous gravel and sand - - - -	
Rubbly chalk - - - -	

"The northern side of the valley by Easton is all in sand and gravel, and makes a sharp feature with steep bluffs. Small sections of Boulder Clay are seen in the sand area, and the clay must be lenticular patches in the sand, as shown in the section just described. The southern side of the valley is a gentle slope of Boulder Clay, and the river here cuts through to the Chalk."

Honingham.—"In a pit over half a mile north-west of Easton, the Chalk is capped by pebbly quartzose gravel and sand, and buff loam."*

Local Details (Southern Tract, and around East Dereham).

Hockering.—The pit a quarter of a mile S.W. of the church, on the sloping ground S. of the road, had been excavated to a depth of about 18 feet, but was much overgrown with grass; a depth, however, of about 8 feet was well exposed, showing very coarse subangular gravel interstratified with brown sand, having a slight dip towards the N.E., or in a contrary direction to the valley. Some of the gravel in the highest part of the pit may possibly be Plateau gravel.

In the same field, and from about 60 to 80 yards to the W. of the above pit, another occurs at a little lower level, in which mostly brown sand, containing a little chalky clay and brown loam in places in the lower part, was exposed to a depth of about 10 feet.

East Tuddenham.—Coarse subangular flint gravel interstratified with buff sand, was well exposed in a pit on the northern side of the road, nearly half

* From Mr. F. J. BENNETT's Notes.

a mile S.S.W. of Hockering Church. A thickness of from 12 to 18 feet or more of gravel was shown, in which were patches of whitish gravelly sand containing numerous chalk-grains. A little brown loam overlaid the gravel in places in the highest part.

Barnham Broom.—On the western side of the pit, five eighths of a mile S. of the church, 4 feet in thickness of coarse subangular gravel mixed with sand, was shown underlying 4 feet of Boulder Clay; but on the eastern side, a much greater thickness of gravel and sand was exposed. The section clearly showed the age of the gravel, the patch being a bulge-up of Glacial gravel and sand, similar to the patch on the opposite side of the valley, three eighths of a mile N. of Brandon Parva Church.

Mattishall.—In a pit half a mile S.W. of Hockering Church, coarse subangular flint gravel, rather dark, similar to that on the sloping ground on the northern side of the valley, and interstratified with brown sand, was exposed to a depth of 9 feet; the excavation, however, had been carried to a depth of about 18 feet, but the lower part was hidden by talus. Some of the gravel in the upper part of this pit may be Plateau gravel, as on the other side.

East Dereham.—A pit occurs a few yards N.E. of the cemetery, on the eastern side of the road, and about half a mile N.E. of St. Nicholas' Church. From about 12 to 16 feet of very coarse gravel intermixed with sand, overlies 20 feet of variously coloured light-brown and yellowish sand, well-stratified in places, and containing a few lenticular patches of brown loam in the central portion. Both gravel and sand occur most irregularly, the latter being much contorted in places. The gravel consisted mostly of flints, but there were many erratics intermixed, amongst others noticed were grey granite, quartzite, grit, sandstone, and basalt, the last more or less decomposed.

At a large pit immediately north of the gas-works, on the eastern side of the road, a little more than a quarter of a mile N. of St. Nicholas' Church, coarse Plateau flint-gravel mixed with reddish-brown sand and loam was exposed irregularly overlying buff Glacial sand, with patches and seams of rather coarse gravel in it in places. The total thickness of the deposits penetrated was about 40 feet or a little more. The Glacial gravel and sand was much contorted in various parts; and at the eastern end, dipped at an angle of nearly 45 degrees. This gravel and sand was well stratified, whereas the overlying beds were devoid of stratification. Some of the flints were much rounded, and from 6 to 9 inches in diameter, and some "paramoudras" as much as 1 foot 6 inches. Some pieces of basalt were observed; they were much worn, but still showed the angles of the columnar structure.

A section at the brickyard, a quarter of a mile N.E. of St. Nicholas' Church, showed 5 feet of clean buff and brown sand, underlying 9 feet of reddish-brown loam containing many large coarse subangular flints. This exposure was on the southern side of the excavation, whereas on the northern side, the sand nearly came up to the surface of the ground. This was also shown to be the case in the excavation made for the drainage-pipes along the road, in a north-easterly direction from the market-place, past the theatre towards the Cemetery Road. In an adjoining brickyard, 16 feet of reddish-brown loam with flints was exposed.

During the construction of the drainage-works along the Commercial Road, at a point directly opposite an old excavation in a brickyard, the following section was exposed:—

Glacial	{	Loam, reddish-brown, with flints	-	-	4 feet.
Drift,	{	Boulder Clay	-	-	2
23 feet.	{	Sand, buff, with several patches of shingly gravel	17	„	

Further south, along the same road, running north and south, the sand was shown to come nearly to the surface, whereas still further south it was found to dip rather suddenly under the Boulder Clay, a considerable thickness of which latter was exposed in the excavation for the drainage-pipes along the most southern portion of the road, and likewise along the cross-road at that end.

During the execution of the drainage-works at the northern end of the market-place, near the obelisk, the excavation made for the sewer-pipes exposed 15 feet of brown and yellowish sand, which was shown to continue along the road by the theatre to that leading to the cemetery. About 6 feet or more of coarse flint-gravel, intermixed in places with sand, and containing

some foreign boulders or erratics, was shown to overlie the sand N.W. of the obelisk, and to extend half way down the steep incline of the road leading to the bridge over the stream, the Boulder Clay being exposed in the excavation in the road for the remainder of the distance down the incline to the level of the Alluvium. From this point southwards, Boulder Clay was exposed in the excavation made along the narrow road, by the houses skirting the Alluvium, to the churchyard; and also in that up the narrow road south of the churchyard, and from there southwards along the narrow road and pathway. The Boulder Clay is overlaid by loam in places, but comes nearly to the surface near the church. Reddish-brown loam, containing coarse subangular flints, was exposed in an excavation made for the drainage-pipes, about three eighths of a mile S. of the church, and running in an easterly direction to the road leading to the level-crossing a quarter of a mile S.S.W. of the railway station. The loam overlaid the Boulder Clay in a very irregular manner, generally being from 4 to 6 feet in thickness but sometimes more. The above excavation was 16 feet in depth, and the pipes rested on Boulder Clay, which was not penetrated.

Scarning.—In a gravel-pit about a mile and a quarter S.S.E. of the church, and south-west of Scarning Old Hall, the following section was exposed:—

Soil -	-	-	-	-	1 to 3 feet.
Glacial Drift.	{	Boulder Clay	-	-	1 to 3 "
		Gravel, mostly of flints	-	-	8 "
		Sand, light-buff, with small flints	-	-	3½ "

The beds undulated considerably, those nearest the road-cutting dipping towards it. There was no passage between the gravel and the Boulder Clay, but a marked line between them. Many of the stones in the gravel were about 6 inches in diameter, and were in a matrix of small gravel, all being much worn. Amongst the intermixed boulders observed were some of basalt, much rounded and decomposed; of Lias Limestone containing *Ammonites*; of ferruginous concretionary nodules; many of Coal Measure (P) sandstones and grits, and of chert containing casts of fossils, &c.

East Bradenham.—A large sand-pit half a mile W. of the church, on the northern side of the road, showed about 15 feet of well-stratified sand, the upper 8 feet of an orange-colour, with a little buff in places, and containing a few patches and seams of angular and subangular flint-gravel, more or less ferruginous in the upper part. The lower 7 feet consisted of very finely stratified whitish and ash-coloured sand, with an occasional band, about half an inch thick or less, of reddish-brown sand. The lines of stratification were slightly undulating.

Sections at Ringland and North Tuddenham are described on pp. 10, 16, 37

CHAPTER VI. GLACIAL DRIFT (*continued*)

UPPER BOULDER CLAY.

General Remarks.

This wide-spread deposit occupies the largest portion of the surface in the district, and was evidently once spread over the whole of it, but has since been partially denuded in some places, and entirely so in others. This denudation was apparently partly effected previously to the deposition of the overlying coarse Plateau gravels, sands, and loams; and the remainder during the earlier portion of the time occupied in the excavation of the valleys.

The formation for the most part consists of Chalk débris, which is intermixed with detritus derived from Oolitic and other rocks. The matrix varies in character from a dark or light grey loamy clay, to a yellowish-white loamy marl. It is unstratified, and crowded with pieces of chalk and flint of various sizes and shapes. The flints, in some cases, have undergone so little attrition during the processes of disintegration, transit, and deposition, that they much resemble those recently extracted from the Chalk. Striated boulders of Oolitic, Igneous, and other rocks occur here and there in this deposit, a few observed, measuring as much as 5 feet in diameter, were much grooved in the direction of the longer axis; the majority, however, were smaller, few measuring more than 3 feet in diameter.

Fossils are to be met with in the boulders, and sometimes in the clayey or marly matrix; but they are all derived, none being of the age of the deposit. This is one of the characters especially distinguishing the Upper from the Lower Boulder Clay; the latter frequently having numerous fragments of marine shells interspersed throughout.

In a few instances in this district, this Boulder Clay had a bedded appearance, much resembling the thin and lenticular bedding of the Chalk. Occasional seams and patches of sand were also observed in it.

The base presents a remarkably sharp and even, although sometimes slightly undulating, line, at its junction with the underlying Glacial sand and gravel; similarly to that at the base of the Lower Boulder Clay at its junction with the underlying Pebbly sand and gravel. The top part of this Upper Boulder Clay, like that of the Lower, presents a very irregular surface when overlain by gravel and sand.

There are many pit-sections which show this clay, varying in thickness from 14 to 25 feet. But, as many of these pits are on

sloping ground, it is certain that in some places, especially on high ground, the Boulder Clay may be thicker. In two well-sections recorded by Mr. F. J. Bennett (*see* Appendix, p. 56) the Boulder Clay is mentioned as being 60 feet in thickness, and in one case not bottomed.

In the following remarks by my colleagues, MESSRS. H. B. WOODWARD and F. J. BENNETT (chiefly relating to the south-eastern portion of the district, which was mapped by them) it will be observed that somewhat different opinions are expressed on the mode of occurrence of some of the Drift deposits over that area, as compared with what I maintain exists in other districts in Norfolk and Suffolk mapped by myself. These differences of opinion however refer only to small questions of classification, not affecting the mapping.

"The structure of the tract southward of Weston is far from regular. The higher ground formed of gravel and sand (which descend to almost the lowest parts of the valley), yet shows here and there, as on Telegraph Hill, old 'marl' or Boulder Clay pits, with a very thin covering of gravel and soil, near the highest levels."

"Near Easton Lodge these marl-pits show sections of Boulder Clay, so like the Upper Boulder Clay that one can hardly resist the conclusion that (in this part of the district) the Upper and Lower Boulder Clays are but parts of one formation, locally varying, and locally separated into two beds by irregular intervening masses of sand and gravel. This view is not necessarily at variance with that which admits the probability of two principal stages of glaciation; the fact being that here and there the distinction is not so marked as it is when we consider generally the evidence furnished by the Cromer Till and the Contorted Drift on the one hand, and the main mass of Upper Boulder Clay on the other. For the disturbances in the Contorted Drift are most likely due to the agent which formed the Upper Boulder Clay."

"Between Easton and Bauburgh one might trace in succession:—

Coarse gravel, on Easton Heath;

Boulder Clay, by Easton Hall;

Sand and gravel, by Bauburgh Hangings and north of Easton Heath;

Boulder Clay, south of Easton Lodge."

"This indication of succession is only locally true after all. The Boulder Clay that rests on the Chalk south of Easton Lodge merges westward and south-westward into the main mass of Boulder Clay."

"In treating of the district further east,* I found it 'most difficult to correlate the sands occupying the plateaux between Norwich, Eaton, and Earlham, for the Chalky Boulder Clay of Mackie's Nursery seems to wedge into them, being distinctly underlaid and overlaid by sand. Again, west of Cringleford, the Boulder Clay occurs as a wedge in the sand.'"

* *Geology of the Country around Norwich*, p. 90; *see also* pp. 92, 93, 103, 118-122.

"The relative position of the Boulder Clay (used as brickearth) at Costessey, of the Boulder Clay at Spring Farm, Attlebridge, by Trowse Junction, at Intwood, &c. cannot be fixed with absolute precision."*

"In the south-eastern corner of the district, and indeed throughout nearly the whole of the southern half of it, a thick spread of chalky Boulder Clay predominates. North of the stream at Honingham and Easton we have a fairly wide area of sand; the southern side is a gentle slope of Boulder Clay and makes little or no feature, while on the northern side there are steep bluffs which are very picturesque."

"The relations of this sand to the Boulder Clay are rather obscure. Some observers would regard it as passing *under* the Boulder Clay; but there are some very instructive sections at Tuddenham, Easton, and Colton which lead to another interpretation. There, instead of the sand underlying the Boulder Clay, we find it distinctly lying on that clay and resting on its flanks, while the stream runs in Boulder Clay. Moreover, some of the sections show lenticular portions of Boulder Clay *in* the sand. All this seems to show that the sand has a very intimate connexion with the clay, that it was formed at the same time, and is therefore of the same age. The coarse cannon-shot gravel, too, behaves much in the same way, resting on the clay, and lying on the flanks of it, but never crossing the valleys."

"To anyone who regards the Glacial deposits as a more or less tumultuous set of beds, dependent in their composition on the varying nature of the country that formed their gathering ground, this evidence of disorder rather than of order strongly commends itself, and from a broad point of view there seems no ground, in the southern part of this area, for formulating any orderly succession of beds such as a triple division, into an upper, middle, and lower, would carry with it."†

Local Details (North of the Wensum Valley).

Billingsford.—Two clay-pits a little more than half-a-mile W. of the church, and N. of Grint Mill, were both much overgrown with trees and bushes, and only a few feet of the Boulder Clay was well exposed. It was grey and whitish in the upper part.

Of two other clay-pits to the E., one on each side of the road, that on the left had been more or less sloped and ploughed over; but that on the right side of the road presented a good section of grey Boulder Clay about 7 feet in thickness.

About half a mile N. by W. of Billingsford Church, are two clay-pits a few yards apart. In each 9 feet of brownish-grey Boulder Clay, weathering to a creamy-white, was exposed, the clay apparently not being bottomed. In the larger of the two pits, north-west of the smaller one, a seam of buff sand, varying from 1 to 3 inches in thickness, occurred in the middle of the Boulder Clay, and the latter in places presented a more or less stratified appearance. It contained numerous small pieces of chalk and of flint, together with large flints, some of which measured a foot in diameter.

From 9 to 12 feet of grey Boulder Clay was exposed in a pit five eighths of a mile N.W. of Billingsford Church, south-west of a small plantation and

* From Mr. H. B. WOODWARD's Notes.

† From Mr. F. J. BENNETT's Notes.

north-east of Bedlam Barn. The clay contained numerous flint and chalk boulders, and its weathered surface was creamy-white. A little brown sand and reddish-brown loam, from 1 to 5 feet in thickness, irregularly overlaid the Boulder Clay, and small patches of sand occurred in the clay, apparently let down into it from above by "piping," &c.

Fozley.—In a clay-pit nearly a mile E.N.E. of Billingford Church, on Coney Hill, the Boulder Clay was greyish, and contained a large quantity of chalk and of flint; 15 feet in thickness was shown in section, and not bottomed.

Bawdeswell.—A pit occurs in a large field $1\frac{1}{2}$ mile W.S.W. of the church, on the southern side of the road, on ground which used to be known as Bittenham Heath. Brown sandy loam with coarse flints, and with irregular patches of chalky grey clay in it, and at the base, was exposed in the upper part to a depth of about 6 or 7 feet. In the lower part there was so much talus that the total thickness of the Boulder Clay could not be seen, but light-buff sand was exposed in places underlying the Boulder Clay.

Bylaugh.—The following section was exposed in a pit in Bylaugh Park, half a mile E. by N. of the church, and a little north-east of the old hall :—

	FEET.
Plateau Gravel. Coarse gravel in a matrix of reddish sand	6
Dark grey Boulder Clay, weathering yellowish-white	6
Sand, buff, and stratified	2 to 3
Glacial Drift. Loam, grey and brown, and stratified	1
Coarse gravel, containing a little buff sand with numerous chalk grains	1
Marl, very stiff and stony	4

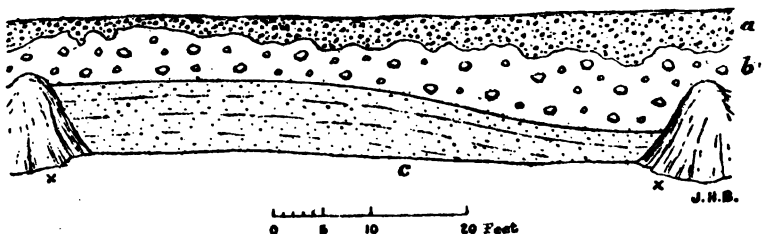
The marl at the base may possibly be a patch in the Glacial sands, similar to some in the cliffs on the coast between Cromer and Mundesley.

A good section, showing the junction of the Boulder Clay with the underlying sand, was exposed in a large pit in Bylaugh Park, and a little more than three quarters of a mile N.E. of the church, in 1883 (see fig. 6).

Numerous flints and pieces of chalk (some striated) occurred in the Boulder Clay, besides erratics. An Oolitic boulder contained numerous shells, amongst which were *Pecten*, *Belemnites*, &c. There was the usual marked line at the junction of the Boulder Clay with the underlying sand, and the former had the appearance of having been squeezed against the latter, the Boulder Clay being more or less dark grey and chocolate-coloured, and very compact and stiff at its base, and for about 3 to 6 inches upwards.

FIG 6.

Section in a Pit in Bylaugh Park, N.E. of the Church.



x Talus.

a. Plateau Gravel, &c., coarse, subangular, with brown sand in places, 3 to 6 feet.

Glacial Drift. { b. Dark grey Boulder Clay, 6 to 12 feet.

c. Sand, stratified whitish and light-buff, 3 to 7 feet +.

Whitwell.—The following section was exposed in a pit, a little more than quarter of a mile W.S.W. of Whitwell Hall :—

Glacial Drift. { Boulder Clay, 6 to 8 feet.
Sand; brown, buff, and whitish, containing fragments of marine shells, 3 feet.

In a clay-pit a quarter of a mile N.W. of Whitwell Hall, from 4 to 8 feet or more of Boulder Clay was shown overlying brown sand. There appeared to be an anticlinal of the sand in the central part of the pit, where the overlying clay was only 4 feet thick.

Great Witchingham.—A clay-pit occurs half a mile S.E. of the church, where about 9 feet in thickness of Boulder Clay was shown overlying brown and buff sand. The clay was grey, and weathered yellowish-white.

A large pit on the high ground three quarters of a mile W.N.W. of Lenwade Bridge, on the northern side of the road, gave the following section :—

Glacial Drift.	{	Boulder Clay, varying from whitish to dark grey, and very chalky, with a few boulders of Lias-shale; 7 to 10 feet.
		Sand, buff and orange-coloured; 4 feet, or more.

Little Witchingham.—In a clay-pit situated seven-eighths of a mile S.W. by W. of Booton Church, 7 feet in thickness of chalky Boulder Clay was exposed. There appeared to be sand at the bottom, but there was no good section, the pit being much overgrown with grass.

Booton.—About 9 feet in thickness of chalky Boulder Clay was exposed in a pit three eighths of a mile N.W. of the church. Another clay-pit occurs a little more than half a mile W. of the church, on the southern side of the road.

Cawston.—In a large clay-pit three quarters of a mile E. of Booton Church, on the northern side of the road, from about 10 to 12 feet of Boulder Clay was exposed; the total thickness here, however, is probably much more, as there was a large quantity of water in the pit, showing that the clay in all probability was not bottomed. A little brown loam overlaid the clay on the southern and western sides of the pit. On the high ground to the east and near Cawston Wood, 5 or 6 feet or more of sand, loamy in places, overlies the Boulder Clay.

Haveringham.—"In large pits in Boulder Clay by the woods east of the Nursery, between Swannington and Brandiston, the clay is capped by a sandy and gravelly soil."

Brandiston.—"A brickyard was opened in the weathered upper part of the Boulder Clay, east of Guton Hall."*

Local Details (West and South of the Wensum Valley).

North Elmham.—A clay-pit seven eighths of a mile N.N.W. of Beetley Church, on the northern side of the valley, and to the west of the wood known as Lawrence Grove, showed 12 feet of Boulder Clay, which apparently was not bottomed. Another section here has been described on p. 8.

Brisley.—In a pit, much overgrown with trees, half a mile N.E. of East Bilney Church, a considerable thickness of grey Boulder Clay was exposed.

Mileham.—From 9 to 10 feet of Boulder Clay was exposed in a pit a mile and three-eighths S.W. of the church, on the eastern side of the Alluvium in the upper part of the Litcham Valley. In two other pits, between this and the road to the north, similar Boulder Clay was exposed.

Stanfield, Tittleshall, and Godwick.—"On the high grounds at Stanfield Green, Tittleshall Hill, Clay-pit Moor, and Godwick, the Boulder Clay is stiff, full of chalk lumps, usually but little decomposed at the surface, and forms heavy land, from which in rainy seasons the water does not readily disappear. Here and there towards Horningtoft and Wellingham the clay becomes more marly, the proportion of ground-up chalk being greater."

"At Tittleshall Hill a pit showed the Boulder Clay with a bed of chalky gravel in it. By an adjoining bank there was a boulder of igneous rock. By the roadside, on a line between Stanfield and Brisley Churches, there was a boulder of quartzite measuring $2 \times 3 \times 1$ feet. North of Burwood Hall, Mileham, there was a large boulder of sandstone, looking like a greywether, and measuring $5 \times 3 \times 2$ feet."*

* From Mr. H. B. WOODWARD'S Notes. For accounts of other sections near Cawston, see Memoir on the Geology of the Country around Cromer.

Litcham.—"West of Litcham Grove a pit showed 12 feet of Boulder Clay, with 'piped' surface, overlaid by an irregular gravelly soil, while beneath the Boulder Clay, 4 feet of white and brown chalky sand with clayey seams was exposed."* See also pp. 10, 11.

East Bilney.—A considerable thickness of grey Boulder Clay was exposed in a pit three eighths of a mile E.N.E. of the church, but the section was much obscured, owing to the pit being overgrown with trees.

Beetley.—In a large clay-pit just N. of the church, the Boulder Clay was overlaid by coarse flint gravel. This was shown also in a pit a little more than a quarter of a mile E. by S. of the church, where the clay was very chalky, and the gravel was 3 feet thick; and again on the southern side of another clay-pit, a little more than three eighths of a mile E.S.E. of the church.

Two other small clay-pits occurred between the last and the farm to the N.E., by the cross roads. Boulder Clay was well exposed in all these pits.

The Boulder Clay exposed in a pit, a little more than half a mile N.W. of Beetley Church, on the sloping ground leading down to the marsh-land to the north, was very chalky.

Gressenhall.—The section in a clay-pit, little more than three eighths of a mile W. by S. of the church, on the lower part of the slope of the valley, north of the stream, showed dark grey Boulder Clay, in which a small boulder of Lias limestone was observed. This clay is overlaid by gravel, indications of which occurred in the upper part of the pit (much overgrown), and the ground was very wet and swampy at the junction.

Beeston.—At a large clay-pit about 300 yards S.W. of Mileham Mill, and nearly seven eighths of a mile S.E. by E. of Litcham Church, in a field on the northern side of the road, from 10 to 12 feet or more of Boulder Clay was exposed resting on Chalk, two feet of which latter was shown in section at the lower part of the pit. The clay was light grey, weathering white, and in places reached the surface of the ground, being of a chalky nature up to the top; in other parts, 3 or 4 feet or more of brown sand and loam irregularly overlaid the clay. A striated boulder, at the bottom of the pit, measured 5 x 4 x 2 feet, and was grooved in several places along its longer axis; it was of exceedingly hard rock, and contained numerous ferruginous concretions.

In a smaller pit, W. of Mileham Mill, and about 200 yards north of that last described, Chalk was exposed about 8 feet beneath the surface of the ground, overlaid by brown sand, loam, and clay; the pit being near the junction of the overlying Valley-deposits with the Boulder Clay.

About 150 yards, or less, north of the above, and some three quarters of a mile E. by S. of Litcham Church, there is another small pit, where 6 feet in thickness of subangular flint gravel was shown resting upon grey Boulder Clay. Water was held up in this pit, whereas there was none in either of the two pits to the south, where the Chalk had been reached.

A pit five eighths of a mile S.E. by E. of Litcham Church, on the southern side of, and adjoining, the road, showed from about 9 to 12 feet of brown loam and Boulder Clay, overlying Chalk. The Boulder Clay immediately resting upon the Chalk, and for about 2 to 4 feet above it, contained a large quantity of Chalk; whereas the 8 feet above consisted mostly of brown stony loam.

Necton.—In a pit at Ivy Todd, on the northern side of the road, a little more than a mile and a quarter E. of the church, very chalky Boulder Clay was exposed to a depth of 10 feet, with not more than from 6 inches to a foot of loamy soil overlying it, the clay in places going up to the surface of the ground. The Boulder Clay was also well shown in a small excavation on the southern side of the road, opposite to the above pit.

At a much overgrown pit, three eighths of a mile N.E. of Necton Church, the Boulder Clay was very chalky and very white.

* From Mr. H. B. WOODWARD'S Notes.

East Dereham.—The following section was exposed at the brickyard a little more than a quarter of a mile N.E. of the railway-station, south of Neat-herd's Moor:—

Glacial Drift.	{	Brown loam, very stony and containing coarse flints, 17 feet.
		Boulder Clay, 3 to 5 feet.
		Coarse gravel, 2 feet.

About 30 yards north of this pit a well was sunk through only 4 feet of brown loam, overlying from 10 to 14 feet of Boulder Clay. On Neat-herd's Moor, adjoining the brickyard, about 3 feet of loam overlies the Boulder Clay, which latter is exposed in ditches near the farm at Galley Moor and elsewhere.

About a quarter of a mile E. of the railway-station, at a brickyard south of the Norwich Road, the loam in places is 10 feet thick, and was said to overlie from about 8 to 10 feet of Boulder Clay, beneath which from 2 to 3 feet of gravel occurs, and then sand.

During the construction of the drainage-works, from 5 to 7 feet in thickness of reddish-brown sand and loam containing large flints, some a foot in diameter, was exposed in the road nearly opposite Dr. Vincent's house, inclining in a south-westerly direction past the southern end of the Commercial Road, where the Boulder Clay was exposed in places within 4 feet of the surface of the road.

Dillington.—A clay-pit about 300 yards to the west of Dillington House, and a mile N.W. of East Dereham Church, showed 15 feet of dark grey Boulder Clay, containing a great quantity of chalk, mostly in small pieces, together with flints and other boulders. One flint measured $1\frac{1}{2}$ feet in diameter.

Hoe.—Owing to the talus in the pit, a little more than three quarters of a mile S.W. of the church, the actual thickness of the clay was not seen. Apparently about 10 to 15 feet of Boulder Clay overlaid well stratified light-brown, buff, and whitish Glacial sand. In a recent excavation at the bottom of the pit, 6 feet of sand was well exposed, in which occurred some small fragments of marine shells (*Cardium*, &c.). Some reddish-brown loam, with subangular flints, irregularly overlaid the Boulder Clay.

Worthing.—In a pit half a mile E. of the church, about 4 feet or more of very chalky marl was shown overlying 9 feet of brownish loam and clay, containing very small pieces of chalk and small angular and subangular flints. Chocolate-brown clay irregularly overlaid the chalky marl or Boulder Clay, and occurred in pockets or pipes in the same.

Another pit in the adjoining field, immediately to the E. of the above, showed 6 feet of very chalky or marly Boulder Clay, containing numerous well-worn large flints. A patch of brown and orange-coloured sand and loam, more or less intermixed, underlaid the above. Two igneous boulders, apparently basalt, lay at the bottom of the pit, and one flint measured $24 \times 15 \times 6$ inches.

At a large pit three eighths of a mile S.S.W. of Worthing Church, from about 20 to 25 feet of greyish and whitish Boulder Clay was exposed, containing numerous small boulders of chalk and flint. The base of this clay apparently rested on chalk, but the latter was not well exposed (only to the depth of about a foot) owing to the water in the pit. On the high ground to the east the Boulder Clay is overlaid by Plateau gravel.

Half a mile E.S.E. of Worthing Church, a pit exposed a thickness of 18 feet of light-greyish very chalky Boulder Clay (weathering white), the lower 9 feet containing many seams and irregular-shaped masses of sand. There were numerous irregular-shaped flints in the clay, many very little water-worn, some so little that they resembled flints recently extracted from the Chalk. Several small flint pebbles also occurred interspersed throughout. There was a tendency to what looked like bedding, similar to the thin and more or less lenticular-shaped bedding that is frequently to be seen in the Chalk.

For an account of another section here, see p. 25.

Swanton Morley.—Two clay-pits occur close together, north and south of the road, about a quarter of a mile S.E. of the church. The clay is yellowish-white and contains numerous small pieces of chalk and flint boulders, some of the latter of the form called "paramoudras." A little brown loamy clay

with coarse flints irregularly overlaid the Boulder Clay in places, and also occurred in "pipes" in the latter. In the pit on the northern side of the road, more or less stratified, gritty sand of various colours (brown, ashy, and white, with black patches in places) underlaid the Boulder Clay. The greatest thickness of clay was shown in the pit south of the road.

In the road-cutting about a quarter of a mile S.W. of the church, a thickness of several feet of grey Boulder Clay was exposed.

A little more than a mile W. of Swanton Morley Church, a clay-pit showed 12 feet in thickness of very chalky grey Boulder Clay, irregularly overlaid by a little reddish-brown loamy clay with flints, the Boulder Clay going up to the surface in places.

Another pit, about 60 yards N.W. of the above, showed 9 feet of grey Boulder Clay, irregularly overlaid by a little reddish-brown clay with flints.

In a clay-pit half a mile E. of Swanton Morley Church, on the western side of the road leading down to the ruins of Swanton Castle, from 8 to 9 feet of Boulder Clay overlaid buff sand; but the junction was not clearly shown, the section being much overgrown and obscured by talus. Another clay-pit occurs a short distance to the west.

On the high ground a mile S.E. by E. of Worthing Church, a large clay-pit gave the following section:—

Plateau Drift. Brown sand, the top 2 or 3 feet more or less gravelly and with some scattered large irregular-shaped flints. In places clayey and loamy, somewhat resembling the Clay-with-flints on the Chalk, in Buckinghamshire, &c.; resting irregularly and unconformably on the clay below; 7 to 9 feet.

Boulder Clay, greyish, weathering white, having the appearance of bedding in places, and with thin seams of sand along the bedding-planes, which in many places resembled the more or less lenticular thin bedding that occurs in the Chalk; 12 to 18 feet.

This bedded appearance of the Boulder Clay was also well exposed in the pit half a mile N.W. of the above, as well as in other places. Large irregular-shaped flints, nodules of chalk, and flint-pebbles occurred throughout the clay; many of the large flints being very little worn, but on the contrary looking more like flints recently extracted from the Chalk. A portion of a "paramoudra" lay at the bottom of the pit. Three distinct undulating parallel lines of bedding were well shown in the upper part of the Boulder Clay; and the line of junction with the overlying sand was most irregular, the marly clay besides being much "piped."

About five eighths of a mile N.W. by W. of Swanton Morley Church, at a clay-pit on the western side of the road, a little north of Little Ease Farm, grey Boulder Clay, weathering white, was exposed to a depth of 18 feet. It contained numerous nodules of chalk and some large flints, a few of the latter measuring 18 inches and more in diameter. From 1 to 3 feet of reddish-brown loam and sand irregularly overlaid the clay, the latter weathering into it; but, in places, the Boulder Clay went up to the surface.

Elsing.—At a large clay-pit, a little north of the stables belonging to Elsing Hall, several feet of Boulder Clay was exposed, but the lower part of the pit was too much overgrown and obscured by talus to show the total thickness. The Boulder Clay was of a chalky nature up to the surface of the ground in places.

A quarter of a mile W. of Elsing Hall, a clean-cut section, by a small plantation adjoining the marsh-land on the southern side of the valley, showed some brown sand underlying Boulder Clay. The latter was in the condition of a reddish-brown loam with irregular patches of chalky clay, but to the south, along the low ground adjoining the Alluvium, it was shown in several places to have its usual character and to contain a large quantity of chalk.

Lyng.—In a large clay-pit half a mile S. of the church, on the western side of the road, about 18 feet of Boulder Clay was exposed overlying sand. The lower part of the clay was dark grey, whilst the upper part was yellowish-white; it contained much chalk, and some boulders of shale were seen in it.

About 12 to 13 feet of chalky Boulder Clay was shown to overlie buff sand, in a small circular pit a mile and an eighth S.E. by S. of Lyng Church, a little north-west of Lyng High House.

Weston.—About 12 feet of chalky Boulder Clay was exposed in a large pit about 200 yards south of Old Barn, and $1\frac{1}{2}$ mile N.W. by W. of the Parsonage.

In a pit in a small wood, a little more than three eighths of a mile N.W. by N. of Weston Church, on the eastern side of the road, the following section was exposed :—

Soil, consisting of reddish-brown stony loam ; 1 to 3 feet.

Grey Boulder Clay, containing much chalk, with more or less horizontal chalky seams and patches ; 16 feet.

“The boundary of the Boulder Clay between Hills Barn and Fran’s Green is vague. There seems to be a sandy wash over the clay of Weston Green.”

Easton.—“Pits in the valley north and north-east of Easton Hall were, I was told, probably opened for brickearth. South of the Hall Boulder Clay was exposed.”

Costessy (in 66, N.E.).—“Mr. F. W. HARMER wrote to me, in 1883, in reference to the brickyard here, mentioning that ‘part of the brickearth contains chalk and burns white ; a short distance off, the same deposit is devoid of chalk. The former is protected from the percolation of acidulated water (which has removed the chalk in the case of the latter) by a band of impervious marly clay.’”*

North Tuddenham.—In a clay-pit nearly a quarter of a mile E.N.E. of the church, on the southern side of the road, from 8 to 10 feet or more of Boulder Clay was exposed, overlying buff sand with a little gravel. Another clay-pit north-west of the above, on the northern side of the road, was much overgrown.

East Tuddenham.—Three clay-pits occur on the high ground, from five eighths to three quarters of a mile S. of Hockering Church, on the southern side of the road. The most westerly showed about 18 feet of Boulder Clay, with from 2 to 3 feet of brown loam overlying it. All were much overgrown, and no good sections were exposed in the other two.

Welborne.—At the north-western corner of the brickyard, a little more than a mile S.W. by W. of the church, a section showed from 6 to 8 feet of Boulder Clay, much intermixed in places with reddish-brown sand and loam, the latter containing many coarse sub-angular flints and occurring in “pipes” and otherwise most irregularly. Underlying the Boulder Clay, from 10 to 15 feet in thickness of brown, buff, and whitish sand interstratified with brown loamy bands was exposed ; beneath which occurred white sand dipping towards the N.W. About 30 yards to the S.E. the sand, which was of a more loamy nature, was seen to be dipping in the contrary direction, to the S.E., clearly showing this to be an anticlinal of the Glacial sand, due to the contortion of the beds at this particular spot ; the sand nearly coming up to the surface of the ground in one place in the brickyard, there being merely a thin covering of loam, containing coarse flints, over it. At the south-western corner of the yard, about 10 feet of grey Boulder Clay was exposed and had not been sunk through, proving that the sand was at a much lower level there. From the high and generally level nature of the surface of the surrounding Boulder Clay, one would scarcely have anticipated finding the Glacial sand so near the surface. However, as several other similar sections have been observed in the district, the disturbed or folded state of the beds is proved.

The reddish-brown loam that irregularly overlies the Boulder Clay is used for the manufacture of red bricks, and the Boulder Clay for drain-pipes, which burn whitish, some being more or less mottled with pink and red.

A little more than a quarter of a mile S.S.W. of Welborne Church, a clay-pit, on the western side of the road, showed 15 feet or more of Boulder Clay ; but as water lay at the bottom of the pit, the above does not probably represent the total thickness of the clay at this spot.

Baughurst.—“About a third of a mile south of the church a pit showed 18 feet or more of Boulder Clay and disturbed Chalk. The latter appeared in places like solid chalk, although much broken up, the flints being scattered irregularly, and there being many broken flints and chips of flint.”*

Barnham Broom.—In a pit three eighths of a mile S.W. by W. of the church, dark grey Boulder Clay, whitish in the upper part, was exposed to a depth of

* From Mr. H. B. WOODWARD’S Notes. See also Memoir on the Geology of the Country around Norwich.

9 feet. Several large irregular-shaped flints occurred in it ; they presented an unworn appearance, and looked almost as fresh as though they had been recently extracted from the Chalk.

In a pit five eighths of a mile S. of the church, 4 feet of Boulder Clay was exposed overlying gravel and sand, which latter bulged up through the clay as shown by the inlier on the Geological Survey Map.

A quarter of a mile N. of Barnham Broom Church, in a clay-pit adjoining the road, on the western side, a thickness of 12 to 14 feet of Boulder Clay was shown, varying from yellowish-white to light-grey. There were several large flints and a few other boulders in the clay, in the upper part, also a seam of brown sand from 4 to 6 inches thick, 4 feet down, and in places patches of chalky gravel.

Carlton Forehoe.—A quarter of a mile W. of the church a thickness of 11 feet of Boulder Clay was exposed in a pit marked on the map.

CHAPTER VII. POST-GLACIAL BEDS.

GRAVEL, SAND, AND LOAM. (PLATEAU DRIFT.)

General Remarks.

Immediately after, or during, the break-up of the glacial conditions which prevailed at the time of the formation of the Boulder Clay, a deposit of coarse gravel was spread out; and after undergoing a certain amount of denudation, was left in a series of outliers. The largest spread in the area here treated of occurs on the high ground to the north and north-west of East Dereham. Similar gravel, and of the same age, has been described in neighbouring and other districts under such names as Plateau gravel, Cannon-shot gravel, and Flood gravel.

In this district there are many pits showing sections of this gravel, which is everywhere unfossiliferous, with a general thickness of about 12 to 18 feet, the greatest thickness observed being 21 feet. The deposit shows no signs of stratification, as a rule, excepting sometimes by included lenticular patches of sand.

The stones of which this gravel is composed consist almost entirely of flint, and are generally from four to nine inches in diameter, with occasional flints measuring sometimes as much as one foot six inches. They are generally much rounded or water-worn, and are frequently compacted closely together with smaller stones, subangular and sometimes angular, in a matrix of reddish-brown sand, loam, or clay; or all of them more or less combined. In some sections, particularly in their upper part, many of the large stones have the longer axis on end. Small boulders of grit, quartzite, &c., are sometimes intermixed with those of flint, but they are comparatively rare.

In some localities, as in the neighbourhood of Billingford Heath and the Norfolk County School, this Plateau gravel reposes, to the eastward, on the Boulder Clay, but overlaps in an unconformable manner the underlying Glacial sands westward. The unconformity of these gravels to the underlying sand was well shown in some sections made during the building of the school chapel. (See also Fig. 7, p. 42.)

In some parts, particularly in the eastern portion of the district, sand, evidently of the same age as the Plateau gravel, overlies the Boulder Clay.

In other portions of the area, and occupying a similar position to the sand last mentioned, there is a considerable quantity of reddish-brown loam, frequently containing large subangular flints, and occasionally some erratics. This is the deposit so largely used for the manufacture of bricks in the neighbourhood of East Dereham, and some other places. Although the deposit varies slightly

in composition, containing more argillaceous matter and more stones in some places than in others, yet, for the most part, it consists of a sandy and stony loam, and the bricks made from it are usually very porous. In consequence of this, some builders put an interior lining of Boulder Clay (which is ready at hand) to the walls of houses, in order to keep out the damp. This sandy and stony loam somewhat resembles the well known "clay-with-flints," and may have been formed in a similar manner. It has a very irregular junction with the underlying Boulder Clay, owing to a large extent to the disintegration and decomposition of the latter, through the dissolution of its carbonate of lime by carbonated water, &c. In consequence of this intimate connexion between the loam and the Boulder Clay, and the very irregular manner in which it occurs in this and other districts, frequently merely as a loamy soil from 1 to 3 feet thick, it has not been distinguished in colour on the Geological Survey Map from the Boulder Clay. In one place at East Dereham, however, it was as much as 17 feet thick (*see* p. 35), and of considerable thickness in several other places. This loam, in many localities, is not in my opinion *merely altered* Boulder Clay, any more than the "Clay-with-flints" reposing on the Chalk in Buckinghamshire, Hertfordshire, and other places, is *merely* the residue of Chalk. On the contrary, in both cases, a superficial covering ("Warp," &c.) of either loam, sand, or gravel, or of all combined, may have contributed towards the formation of the deposits.

Local Details.

Beeston.—About one and three eighths of a mile E.N.E. of the church there is a large gravel-pit, on the northern side of the road, showing 11 feet of coarse flint-gravel resting on Boulder Clay. The stones in the gravel were mostly from 4 to 6 inches in diameter, but a few measured as much as 12 inches; they were closely packed in a matrix of red clay and sand. No erratics or foreign boulders were observed in the gravel, which appeared to consist entirely of flints, all much rounded and worn. The floor of the pit was apparently wholly Boulder Clay, which was well exposed around some ponds a few yards to the west and at a lower level, the evidence clearly showing that the gravel *overlies* the clay. Another pit, now much overgrown, a few yards to the north of the above, shows gravel overlying Boulder Clay.

In a pit three quarters of a mile N.E. by N. of Beeston Church, very coarse flint-gravel was exposed to a depth of 12 feet. Many of the flints measured from 7 to 12 inches in diameter, and they were embedded with smaller stones in a matrix of reddish-brown sand and clay. Boulder Clay had apparently been excavated at a lower level in another part of the pit, which, however, was so much overgrown that no section was exposed.

In another gravel-pit about 200 yards N.W. of the above, now overgrown with trees, a recent excavation at the south-western corner exposed about 5 feet of similar coarse gravel; the total thickness, however, is probably as great in this pit as the former.

Litcham, Tittleshall, Stanfield, &c.—"The gravel and sand of these places appear generally to rest on the Boulder Clay. An exception has been noted west of Litcham Grove, but, as lenticular beds of sand and gravel sometimes occur in the Boulder Clay, that may have been the case there. At one time I was disposed to regard the gravel and sand west of Brisley as intercalated in the Boulder Clay; but this was disproved by Mr. BLAKE, in tracing the gravels further south. The beds occur at very irregular levels, and near Mileham almost merge into the Valley-gravel. Opposite the Unicorn

Inn is a section which showed the Boulder Clay and gravel in rather abrupt contact."

"West and south-west of Brisley, some of the pits show coarse gravel of the cannon-shot type, while towards Stanfield Green there are sand-pits. South-west of Stanfield Church the gravel and sand are intermingled. Several pits in coarse gravel may be seen between Mileham and Litcham. In the Litcham chalk-pit, an irregular deposit of gravel and sand rests in pockets on the Chalk; and north-west of Mileham Warren there is 12 feet of rather coarse gravel, rudely stratified."

"South-west of Tittleshall Church a pit showed about 18 feet of rough flint-gravel resting on clay. The surface of Tittleshall Common is light and loamy, but there appeared to be no sufficient thickness of sand or gravel to mark it on the map."

"On Wellingham Heath there are pits showing coarse gravel and sand, the former mostly at top."*

Gressenhall.—A good section in the large pit in the field a few yards N. of the church, showed 15 feet of coarse flint-gravel. The stones were mostly well-rounded and from 2 to 8 inches in diameter, a few measuring as much as a foot. On the northern side of the pit there was an irregular patch of more or less stratified coarse brown sand, and, in places, some fine sub-angular gravel stained of a chocolate-colour. Most of the gravel seemed devoid of stratification, and many of the stones had the longer axis on end, particularly in the upper part. The new tower to the church and other recent restorations, were, I believe, made with large water-worn flints from this pit.

East Dereham.—Plateau gravel, sand, and loam, occur in places on the high ground in the neighbourhood of Quebec House, and westward and south-westward of the water-works.

Hoe.—A fine section, in a large gravel-pit on the northern side of the little valley, and west of the railway, nearly three quarters of a mile W.N.W. of the church, showed 21 feet of coarse, well-rounded flint-gravel, continuous with, and clearly of the age of, that which overlies the Boulder Clay on the eastern side of the railway-cutting, itself excavated through the gravel. On the eastern side of the railway the gravel becomes less and less thick, until the Boulder Clay comes up to the surface. The gravel in the pit consisted of flints, mostly from 4 to 11 inches in diameter, thickly massed together in a matrix of reddish-brown sand containing some smaller flints. A few lenticular patches of stratified reddish-brown sand occurred in places, also six or seven more or less horizontal but impersistent lines of black manganese-staining; but the whole mass presented an unstratified appearance.

Worthing.—A good section, demonstrating the position of the Plateau gravel, was shown in a pit nearly five eighths of a mile S. of the church, as follows:—

Plateau Gravel. Coarse flint-gravel resembling beach-shingle, composed almost entirely of well-rounded flints, mostly from about 4 to 7 inches in diameter; 6 to 9 feet.

Upper Glacial. Boulder Clay, not bottomed; water in the lowest part of the pit; 18 to 20 feet.

The gravel overlaid the Boulder Clay very irregularly, and wrapped over it on the sloping ground towards the railway.

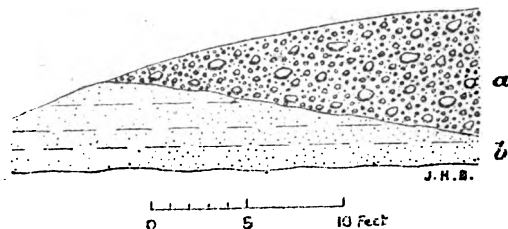
Billingford.—In a pit five eighths of a mile S.E. of the church, on the top of the steep escarpment and on the southern side of the road, 9 feet of coarse gravel was exposed, consisting of well-worn flints, generally from 3 to 6 inches in diameter, closely compacted in a matrix of fine sub-angular flint-gravel.

A good, clean-cut section, a mile N.E. by N. of North Elmham Church, at the south-western corner of a plantation N.E. of the Norfolk County School, showed the gravel resting unconformably on Glacial sand, as in Fig. 7.

* From Mr. H. B. WOODWARD'S Notes.

FIG. 7.

Section in a Pit a mile N.E. by N. of North Elmham Church.



- (a.) Plateau Gravel. Unstratified, coarse flint-gravel; many of the flints well-rounded, others more or less subangular; 7 feet.
 (b.) Glacial Drift. Finely and horizontally stratified buff sand; 4 feet or more.

Bylaugh.—There are two gravel-pits seven eighths of a mile E.S.E. of Billingford Church, on the northern side of the valley, a little north of the north-western corner of the plantation. The gravel was reddish-brown, and apparently consisted entirely of flints, many of them much water-worn, the largest being about 9 inches in diameter. About 6 feet in thickness was shown in each of the pits, the total thickness not being exposed. In places some sand was intermixed with the gravel.

In a large gravel-pit in Bylaugh Wood (now part of Bylaugh Park), three quarters of a mile N.W. by N. of Bylaugh Church, from 6 to 7 feet of coarse flint-gravel was exposed, and was shown to come well up to the surface of the ground on all sides of the pit, with the exception of the north-western corner, where it was very irregularly overlain by reddish-brown stony sand and loam from 3 to 5 feet thick. This surface-deposit was more or less indurated in places, and sometimes occurred in pockets, as it were, in the gravel, somewhat like the "piping" which occurs in Chalk, Marl, Boulder Clay, &c. The flints composing the gravel were much water-worn, and mostly from 4 to 6 inches in diameter, but larger flints occur in the same spread of gravel in other parts of the park.

On the eastern side of Bylaugh Wood, and north-west of the brickyard, coarse flint-gravel was excavated in 1883, to metal the road on that side. Two small pits were opened adjoining the road, where 3 feet of gravel was exposed, intermixed in places with some brown sand. These pits were for the most part filled in after the flints for the metalling of the road had been obtained.

At the western end of the pit, illustrated by Fig. 6, p. 32, and on the southern side, the Boulder Clay was overlain by from 4 to 6 feet of red sand, indurated in places, and more or less intermixed with coarse flint-gravel.

Bawdeswell.—Coarse flint-gravel, from 4 to 6 feet or more in thickness, and unconformably overlying buff Glacial sand, occurs as an outlier on Bawdeswell Heath, north of Bylaugh Park. (See p. 23.)

Swanton Morley.—A section here is noticed on p. 36.

Shipdham.—A good section was exposed in a large gravel-pit about 300 yards E.S.E. of the church, as follows:—

Sandy loam, reddish-brown, and containing coarse flints; 3 to 6 feet.

Coarse flint-gravel; many of the flints from 6 to 12 inches in diameter, and a few 18 inches; 9 to 12 feet.

In an excavation on the eastern side of the cemetery, 12 feet in thickness of coarse flint-gravel, similar to that in the above pit, was exposed.

Letton.—In a pit three eighths of a mile S.W. by W. of Letton Hall, coarse unstratified flint-gravel, containing some lenticular patches of brown and reddish-brown sand in a few places, was exposed to a depth of 16 feet. The flints on the whole were much water-worn, and from 4 to 8 inches or more in

diameter; they were in a matrix of fine buff and reddish-brown gravelly sand, many of the small flints in which were angular and subangular.

Cranworth.—At a pit a little more than three eighths of a mile N. of the church, a thickness of 10 to 15 feet of unstratified coarse flint-gravel, much water-worn, was exposed overlying at least 10 feet in thickness of buff sand, which seemed to have a tendency to stratification in places. The gravel, which was similar to that in the pit S.W. of Letton Hall, overlaid the sand in an undulating manner; it is on high ground, and Boulder Clay was well exposed in many places on lower ground N.E. and S.W.

Necton.—A small pit occurs in the corner of the field immediately west of the Three Tuns Inn, at the crossing of the roads. On the northern side 8 feet in thickness of very coarse subangular flint-gravel was exposed, and at the southern side, about 20 feet from the former, 6 feet of brown sand was shown, containing seams of small flint-gravel. The gravel apparently overlaid the sand, and consisted almost entirely of flints, many of them much rolled and from about 4 to 9 inches in diameter.

Another gravel-pit occurs a quarter of a mile N.E. of Necton Church, on the southern side of the road. A similar kind of gravel to that above described was exposed, consisting mostly of flints from 4 to 9 inches in diameter; some subangular, others more rounded. A few small boulders of grit about 4 inches in diameter were the only boulders noticed besides flint. Fine gravel was intermixed in places with the coarse, some of which was stained more or less of a blackish colour. Mr. BENNETT noted in this pit "reddish clay, and in one part a small patch of Boulder Clay; so that the former may be the latter weathered." In the road, north of the above pit, a section of gravel was exposed.

The following Notes are by Mr. BENNETT:—

"On the other side of the road, in the plantation, are some old much overgrown pits. Here fine buff sand was seen. In both these pits the gravel and sand must rest on the Boulder Clay."

Holm Hale.—"Half a mile and more north-westward of the church a patch of sand has been mapped, in which a small pit was seen showing some 3 feet of buff sand."

West Bradenham.—"Half a mile north-west of the church, and just south of the school, a pit showed the following section, with a steady dip toward the valley. Boulder Clay underlies the gravel and sand:—

Angular and subangular gravel, rather fine; 7 feet.

Fine gravel and sand interstratified; 5 feet.

Brown sand: 5 feet.

"A little south-west of the last pit, north of the road, and close to it, is another with rather coarse brown and white sand, evenly bedded, 12 feet thick. A thin line of gravel occurs about the middle of the pit, with sharp angular flints and bits of carstone? There is another seam of gravel near the top."

Reymerstone.—"A quarter of a mile east of Southburgh Church and close to the road is a very large pit, with 12 feet of coarse much-rolled gravel."

"Another pit in the same patch of gravel, a mile east of Southburgh Church and east of Cavelly Farm, shows 6 feet of coarse much-rolled gravel in a fine angular gravel matrix. The gravel is ferruginous, and has in one place a layer of flaggy iron-sandstone. An irregular band of carbonaceous matter runs through the pit."

Hardingham.—"In a pit just south of the church sand has been dug. A little more than half a mile west of the church a gravel-pit shows about 6 feet of rather fine angular gravel."

Thuxton.—"Half a mile south of the church a pit shows 8 feet of coarse gravel. Half a mile south-east of this, and close to the railway, is another pit, showing 5 feet of coarse gravel in a sandy matrix. A mile east of Reymerstone Church a pit shows 3 feet of coarse gravel."

Kimberley Park.—"A little north-east of the house a pit shows sand and gravel over Boulder Clay. Half a mile north-north-west of the house is an old pit in coarse gravel."

Great Melton.—"West of Hall Farm, in the triangle (Whipple Green) formed by the footpath and the angle of the road, is a pit showing coarse gravel and sand interstratified, with a seam of chalky gravel and loam in one part."

"Half a mile east of the church as very large pit showing coarse gravel over brown sand, in all 20 feet."

"A quarter of a mile north of this is another pit with coarse gravel, not bottomed at a depth of 12 feet, and close to it a pit showed 6 feet of Boulder Clay."

"At Rye Hill, three quarters of a mile east of Barford Bridge, coarse gravel is seen in the wood on the sharp slope of the valley. It must occur as a mass in the Boulder Clay which is seen above and below it; west of this is another patch of gravel capping the high ground."

"At Bow Hill, three eighths of a mile south-east of Marlingford Church, there is a large pit, but the section is not very clear and the beds seem to dovetail into each other, to show no regular order, and to occur thus:—

Coarse gravel.

Glacial	{	Boulder Clay, a lenticular patch on one side of the pit.
Drift.		Sandy loam.
		Fine gravel.

Very coarse gravel with very large blocks of flint. This may possibly represent the stony bed of the Norwich Crag.

Chalk.

"Boulder Clay is seen all round this section. East of it are some small patches of gravel, and a mile and a quarter east, just at the edge of the sheet, is a sharp rise capped by buff sand, of which 6 feet is shown."

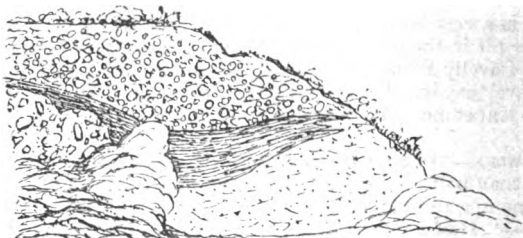
"At Algarsthorpe there is a patch of gravel with Boulder Clay above it, but making no feature at the junction, which is on the high ground. On the lower ground the gravel rests partly on Boulder Clay and partly on Chalk. There is no good section in the gravel, but it is most likely to be a bed in the Boulder Clay."

Wramplingham.—"Half a mile east of the church there is a large much overgrown pit showing gravel with Boulder Clay. Chalk was touched at the bottom."

Colton.—"About three quarters of a mile south-east of the church coarse gravel is seen on the high ground, descending also the slopes and making a sharp feature. Its junction with the Boulder Clay at the top of the slope is not easily seen, and it makes no feature, and this is nearly always the case about here. Boulder Clay is seen in the bottom of the valley, so that here again the gravel may be regarded as an included mass in the Boulder Clay. This mode of occurrence of the gravel in the Boulder Clay may be seen in a very interesting section in a thick wood at the end of the road leading into the wood from another gravel-pit about five eighths of a mile E.S.E. of Colton Church, as in Fig. 8."

Fig 8.

Section in a Pit E.S.E. of Colton Church.



4. Coarse cannon-shot gravel; 9 feet.

3. Brown loam, formed by the dissolution of the Chalk from the Boulder Clay. The dissolution becomes complete where the clay is underlaid, as well as overlaid by the pervious beds 1 and 4; 0 to 4 feet.

2. Boulder Clay, against which 1 and 4 abut, the part hidden by talus being all clay.

1. Brown and buff sand, up to 9 feet.

"North of the last pit, and at the top of the road leading down to it, is another large pit, partly abandoned, with coarse gravel, 12 feet thick."

Colton (from Mr. WOODWARD's Notes).—"North of the church the ground is light and gravelly. Brickearth and clay were at one time exposed in digging at the Parsonage; and also at the cottage about half a mile south-west."

Honingham.—"North of the church are two pits in coarse gravel, 6 feet deep. Half a mile south-west of the church is a small section showing 6 feet of buff sand, with Boulder Clay at the bottom."

East Tuddenham.—"Three quarters of a mile eastward of the church are two sand-pits; the one just S.W. of Berry Bridge shows 15 feet of brown bedded sand. A quarter of a mile south of this is another very large pit showing 15 feet of brown sand. Half a mile east of the church a pit in a wood showed a like thickness of sand; and a quarter of a mile east of the church is another sand-pit."

"This sand forms a decided feature on the flank of the valley, but not on the top of the slope; at the bottom, the junction with the Boulder Clay is clearly marked by springs, and this absence of feature at the top seems to show that the sand is there banked against the clay."

"A mile a little north-east of East Tuddenham Church there is another patch of sand."*

[From the above notes, it seems that Mr. BENNETT does not regard all this gravel as newer than the Boulder Clay; but is inclined to take some of it to belong to that deposit, occurring as layers or banks in the clay. W. W.]

North Tuddenham.—"In a pit three eighths of a mile N. by W. of the church, a thickness of from 10 to 12 feet of coarse unstratified flint-gravel, in a matrix of brown sand, was exposed. The stones were of various sizes, up to about 9 inches in diameter, some well-rounded, others more or less subangular, and many of the larger flints had the longer axis on end."

Easton.—"Coarse gravel was exposed west of the Lodge, Easton Heath; and again south-east of the Lodge. The gravelly nature of the subsoil is hidden in places by a loamy soil, which keeps the ground wet in rainy weather. East of Easton Hall a sand-pit has been opened."

Marlingford.—"In the hill north-west of the Old Hall, a pit has been opened in coarse gravel; and by the plantation about a third of a mile S.S.W. of the church, a pit showed from 8 to 10 feet of stratified subangular gravel and sand."

Bickerstone, Welborne, and Barnham Broom.—"Gravel and sand rest irregularly in patches on the Boulder Clay."

Baiburgh.—"The hill between Baiburgh and Low Common is capped by a sandy soil of no great thickness, a continuation of the deposit exposed near Colney (Quarter-sheet 66, N.E.)."†

* From Mr. F. J. BENNETT's Notes.

† From Mr. H. B. WOODWARD's Notes.

CHAPTER VIII. POST-GLACIAL BEDS (*continued*).

VALLEY GRAVEL.

General Remarks.

There is a considerable quantity of gravel here and there in the Wensum Valley, in large banks or terraces, first on one side, then on the other. Since it was deposited, a large quantity has been denuded by the river, in cutting its way through and deepening its course, the consequence being that, in places, the surface of some of the banks is now 18 to 20 feet or more above the present level of the river.

The deposit, which varies somewhat in composition and condition, consists mainly of subangular and well-rounded flints, intermixed with flint pebbles and a little buff or brown sand, the last sometimes occurring in thin bands, and sometimes in lenticular patches. Small boulders of quartzite are occasionally met with, and also small angular fragments of flint. Whilst in many places there are but slight or rough indications of stratification, in some there is distinct stratification and also a little false bedding. No shells of the age of the deposit have been observed in the district. The conditions which prevailed at the time when this old Valley-gravel was deposited, were obviously very different to those which now obtain.

Some of the gravel in the other valleys is of much more recent date than that in the Wensum Valley, referred to above.

Local Details. Ouse System.

Valley of the Nar or Setchy.

Litcham. — Some small pits occur close together on Litcham Common, three eighths of a mile S. of the church. The gravel consists almost entirely of flint, mostly angular and subangular, but with a few scattered well-rounded flints, the stones varying from about 2 to 4 inches or more in diameter. The gravel irregularly overlies, and in places is intermixed with reddish-brown loamy sand and sandy loam, exposed to about 6 feet. This loam is similar to, and possibly of the same age as, the loamy deposit that overlies the Boulder Clay in so many places, and occurs here on the gentle southern slope of the valley, reaching up to a considerable elevation. Beyond an occasional small grit-boulder, from about 4 to 6 inches in diameter, no other foreign boulder was observed.

About 200 yards north of the above pits, lower down the slope, and at the northern side of the common, a thickness of 2 to 3 feet of mottled reddish-brown and grey loamy clay was exposed, similar to that frequently seen overlying the Boulder Clay, and apparently a continuation of that in the pits above described.

Beeston. — The section here is described on p. 40.

Valley of the Wissey or Stoke.

(From Mr. F. J. Bennett's Notes.)

Necton.—A rather wide spread of Valley-gravel has been mapped here, but there are no sections, and it merely consists of a thin coating of rather coarse subangular gravel.

The streams in the southern part of the area seem now to be accumulating gravel rather than finer alluvium.

*Local Details. Yare System.**Valley of the Yare.*

(From Mr. F. J. Bennett's Notes.)

Hardingham.—There is gravel south of the church.

Kimberley.—Gravel preponderates along the stream here, but no sections were to be seen, and it is of no great thickness.

Valley of the Wensum.

Swanton Morley.—A gravel-pit occurs a little more than a quarter of a mile S. of Bylaugh Church, on the sloping ground south of the river, and adjoining the marsh-land. A good vertical section showed 10 feet in thickness of gravel, slightly stratified, and containing a few horizontal but impersistent bands of brown sand from 4 to 6 inches in thickness. The gravel consisted almost entirely of subangular and well-rounded flints intermixed, with an occasional small boulder of quartzite.

Bylaugh.—Subangular flint-gravel, intermixed with brown sand, is well shown in places along the Valley-gravel escarpment N. of Elsing Mill, on the eastern side of the road and north of the river. The surface of the gravel here is from 15 to 18 feet above the level of the Alluvium.

At two small pits on the sloping ground on the northern side of the Wensum Valley, about a quarter of a mile N.W. of Elsing Mill, and about three eighths of a mile E. of old Bylaugh Hall, from 12 to 15 feet in thickness of subangular flint-gravel was exposed, some of the flints being red or claret-coloured. In the most westerly of the two pits some more or less stratified buff sand was intermixed with the gravel, the latter being somewhat coarse in the upper part.

Sparham.—In a pit three eighths of a mile E. of Lyng Church, 15 feet or more of gravel was exposed, consisting of angular and subangular flints intermixed with brown and buff sand and flint-pebbles. This extends across Sparham Common.

Great Witchingham.—Nearly five eighths of a mile W. by S. of Lenwade Bridge, an interesting section of Valley-gravel was exposed in a road-cutting, through a small plantation, leading down to the marshes west of Witchingham Moor. The gravel, very similar to that so well exposed in Thorpe railway-station-yard at Norwich, was more or less intermixed with buff sand, was distinctly stratified in places, and sometimes a little false-bedded. It consisted of angular and subangular flints with pebbles intermixed, and was about 18 feet in thickness, above the level of the adjoining marsh-land. On the sloping ground of the section, just north of the Alluvium, the horizontal lines of stratification were sharply cut off, clearly proving that the valley had been considerably deepened since this gravel was deposited.

A large pit a little more than a quarter of a mile W. of Lenwade Bridge, showed from 6 to 8 feet of angular and subangular flint-gravel intermixed with buff sand, and overlaid by about the same thickness of stratified buff sand. At the bottom of the pit, 2 or 3 feet of gravel are said to have occurred, and then water was found.

About 4 feet in thickness of angular flint-gravel was exposed in a small pit on Witchingham Moor, about a quarter of a mile south of the above.

In a small gravel-pit a mile E. of Sparham Church, about 200 yards south of the road S. of Whitwell Common, a thickness of 7 feet of reddish-brown

gravel was exposed. It consisted of angular and subangular flints intermixed with pebbles and a little reddish-brown sand.

Attlebridge.—A patch of Valley-gravel occurs adjoining the Alluvium, on the northern side of the River Wensum, between Alderford Common and Attlebridge Church. At about five eighths of a mile S. of Alderford Church, several sections were exposed in this gravel during the construction of the Eastern and Midlands Railway. It consists of angular and subangular flints intermixed with pebbles, and is apparently about 15 to 18 feet thick.

Swannington.—Mr. H. B. WOODWARD states that "traces of Valley-gravel border the Alluvium west of Joles Farm."

ALLUVIUM.

General Remarks.

This deposit forms the marsh-land of the district, a comparatively flat tract along the base of the valleys. In the Wensum Valley this tract averages about a quarter of a mile in width, becoming of course gradually less in the upper portions of its tributaries. Its boundary-lines are for the most part sharply defined, the deposit forming a marked feature along the foot of the slope on either side of the valley. The Alluvium along the base of the other valleys in the district, averages about an eighth of a mile in width. In many parts this alluvial ground is still subject to floods; but owing to artificial drainage very little "warping," or subsidence from muddy waters on flooded areas, now takes place. Where boggy and low-lying tracts of marsh-land exist whose surface is beneath that of the river, an artificial process of "warping" (by raising banks around the area and enclosing the muddy water, &c.) would in many cases much improve the value of the land by raising its level. The bed of the river should also be kept low by periodical dredging, the material being used to form banks along the river-side.

The composition of the existing Alluvium varies in different localities; silt, loam, peat, clay, sand, marl, and gravel, all more or less entering into its composition and occurring near its surface in certain areas. Beyond, however, what is to be seen along the sides of "dykes" or ditches, very little information respecting it is to be obtained. The best section that came under my observation was that at Morton, mentioned below.

Local Details.

Valley of the Wensum.

Morton.—During the excavation for the foundations of the railway-bridge over the river, five eighths of a mile S. by W. of Alderford Church, the following section was exposed:—

Alluvium	{	Peat; 4 feet.
		Black silt, with numerous fresh-water shells, hazel-nuts, fir-cones, and wood; 8 feet.
		Grey sand and silt; 4 feet.

Gravel.

At 12 feet down, a large lower-jaw of *Cervus* was found in a beautiful state of preservation, and with all the teeth in it; at 10 feet, a large skull of *Bos*; and in the black silt I obtained some bones of sheep, and many

specimens of the following species of fresh-water shells, which have been identified by Messrs. G. SHARMAN and E. T. NEWTON.

Bithynia tentaculata, Linn.
Clausilia laminata, Montagu.
Limnæa palustris, Drap.
 ——— *peregra* (?), Drap.
 ——— *stagnalis*, Linn.
Neritina fluviatilis, Linn.
Planorbis carinatus, Müll.
 ——— *complanatus*, Linn.

Planorbis vortex, Linn.
Succinea putris, Linn.
Valvata cristata, Müll.
 ——— *piscinalis*, Mull.
 ———
Pisidium amnicum, Linn.
Sphærium corneum, Müll.
Unio tumidus, Philip.

East Bilney.—Sir R. Owen records the Reindeer (*Cervus tarandus*) “afforded by the discovery of a fragment of the skull with the antlers attached, beneath a peat-moss in a small moor at East Bilney A drawing of these antlers, transmitted to me by C. B. Rose, Esq., is engraved in cut 197.”*

Valley of the Nar or Setchy.

Litcham.—A little black peat was exposed overlying the loamy clay in places along the low ground on the northern side of Litcham Common.

* British Fossil Mammals and Birds, p. 481.

CHAPTER IX. ECONOMIC RESOURCES.

Building-Stones.

Some beds of the Medial Chalk have been used for building-purposes, as well as the nodules of flints in both the Upper and Medial Chalk. The very irregular-shaped flints are often used for ornamental purposes, in gardens, &c. The large flints that occur in the coarse Plateau gravel, and which are generally much water-worn, are also used for building-purposes. Gressenhall Church has recently been restored with flints from a gravel-pit in the adjoining field.

Whitening and Lime.

I know of only one place in the district where the manufacture of whitening or whiting now exists, Litcham.

There are lime-kilns in chalk-pits at Litcham, Swanton Morley, Lyng, Alderford Common, and elsewhere; where at the present time chalk is quarried and burned into lime.

Road-Metal.

Gravels of various geological formations are used for road-metalling. Valley gravel, Plateau gravel, Glacial gravel, and Pebbly gravel are all used.

In the Boulder Clay country, the stones gathered from the fields are much used, and are very excellent for the purpose, having been well exposed to the air, and thereby hardened. Fresh flints from the Chalk are sometimes used; but these, after being broken, should always be exposed to the action of the atmosphere for several months, before being put on the roads.

Brickearths and Sand.

The stony loam that overlies the Boulder Clay is used to a large extent for the manufacture of red bricks, particularly in the neighbourhood of East Dereham, and at Weston. The bricks are usually very porous owing to the generally sandy nature of the loam; but better bricks are sometimes made, when the loam is stiffer or more clayey.

The Boulder Clay, when it is dark grey, freed from stones and pieces of chalk, and well puddled, makes very good bricks, tiles, and drain-pipes, of a yellowish white and often mottled with pink.

Bricks are also occasionally made in the district from the loams and clays that occur in the other divisions of the Glacial Drift;

these brickearths are often greyish and blackish, generally make the best bricks, and usually burn to a yellowish white. Some of this kind have been made in the neighbourhood of Bylaugh.

Clean buff and whitish sand, suitable for making mortar, and for use in brickyards, foundries, &c., is mostly obtained from the Glacial and Pebbly sands.

Manures.

Besides Chalk, the Boulder Clay (which is the sub-soil over the greater part of the district) is now occasionally, but formerly was very extensively, used as a fertiliser.

MR. R. N. BACON says, "there is no county which has been indebted more, if so much, to the manures obtained from its subsoils, as Norfolk, and by none has a larger quantity been used, or with a greater increase of production. . . . The consequence has been that no county, and certainly no district exhibits to a greater extent the proof of this application, to be seen in the number of clay and marl pits which abound on every farm. . . . The proper quantity to be used of these fertilizers depends very much on the nature of the soil. Upon the very light from thirty loads per acre would be applied in the autumn, either on a fallow or on an olland, well spread and left to the effects of the elements, and it is necessary in some instances to renew the same dressing every ten or fifteen years, according to the length of the lease. Upon mixed soils from twenty-five to thirty-five loads. Upon black loose sand, as well as on new broke-up land, not less than one hundred loads per acre. This is practised by some, while by others a reverse opinion is maintained. The latter, considering that even upon loose soils clay should be used in smaller quantities and oftener with greater advantage; the large sinking without pulverizing. The writer lately saw a black soil opened, which had been heavily clayed twenty years since, when the clay was found to have sunk so far that no benefit could be derived by any crop, and laying in a solid stratum. Had a smaller dressing been given, it would have pulverized and amalgamated with and given a staple to the surface soil. Upon good loams about twelve loads, renewed once in twelve years—upon some of the tender fertile moulds, from thirty to forty loads; and upon the heavy soils not less than forty loads per acre, are the quantities commonly used."*

Water.

Besides the supplies to be derived from the rivers and streams, there are sources of water-supply in the following formations:—The Plateau gravel and sand, the Glacial sand (beneath the Boulder Clay), the Pebbly Series, and the Chalk. The details of wells in these various water-bearing beds are given in the Appendix (p. 54).

The following list contains information respecting the surface-levels and the water-levels of several wells in East Dereham and in the surrounding parishes. The levels are given in feet and were obtained by Mr. BALDWIN LATHAM, M. INST. C.E., who was consulted about a new water-supply for East Dereham. He kindly sent a map containing the information respecting these levels to my colleague Mr. W. WHITAKER, who communicated it to me, and from it the following table has been drawn up.

* Prize Report on the Agriculture of Norfolk, pp. 267, 272, 273 (1844).

LIST of WELLS, showing Surface-levels and Water-levels above Ordnance Datum.

Parish.	Site of Well.	Above Ordnance Datum.		Depth of Water below Surface.
		Surface-level.	Water-level.	
Beeston	Tile-kiln, 1 mile N. by E. of church	201'16	163'06	37'50
	Newhouse, 1½ mile N.E. of church	189'11	166'81	22'30
	Near stream, nearly ½ mile E. of above well	216'96	167'48	49'48
Dillington	½ mile W. of Dillington House	129'41	117'44	11'97
East Dereham	N. of Toft Wood Mill, on eastern side of road, 1½ mile S. of church	161'97	147'97	14'00
	W. of South Green, ½ mile S. by E. of church	162'08	147'03	15'05
	½ mile S. by E. of church	167'99	146'49	21'50
	½ mile E. of railway-station, on southern side of road	175'09	152'09	23'00
	Nearly ½ mile E. of railway-station, N. of mill	176'29	161'29	15'00
	Etling Green, 1½ miles E. by N. of railway-station	181'49	146'65	34'84
	½ mile N.W. of church	130'45	129'35	1'10
	½ mile N.E. of church	179'18	149'18	30'00
	A little more than 1½ miles N.E. of church, on eastern side of road	203'24	151'24	52'00
	N.E. corner of Buckstone Wood, and ½ mile N. of church	139'44	128'14	11'30
Gressenhall	Nearly ½ mile N. by E. of church	120'06	109'96	10'10
	Nearly ½ mile E.S.E. of church	105'87	102'17	3'70
Litcham	Chalk pit, ½ mile E.N.E. of church	179'08	?	?
	Near stream, ½ mile S.E. of church	155'29	152'09	3'20
Little Fransham	½ mile S.S.E. of church, on northern side of road	217'99	207'39	10'60
Longham	Near stream, S. of Ostrich Inn and ½ mile E. by S. of church	189'54	168'64	20'90
North Tuddenham	1½ mile N.W. by W. of church, on northern side of Norwich road	137'67	134'87	2'80
	½ mile N.W. by W. of church on northern side of road	131'56	124'41	7'15
Scarning	½ mile W. of church, on northern side of road	190'98	181'48	9'50
	Close to, and S.E. of church, on southern side of road	209'6	188'3	21'3
	½ mile E.N.E. of church	161'91	154'18	7'73
Shipdham	½ mile N.E. by E. of church, on northern side of main road	231'36	222'49	8'87
	½ mile E.N.E. of church, on southern side of road	232'35	215'15	7'20
	Thorpe Row, northern side, 1½ mile N.E. of church	253'78	253'78	0'00
	Near Lolly Moor, 2½ miles N.E. of church, on western side of main road	166'09	166'09	0'00
Swanton Morley	1½ mile S. by W. of church, on eastern side of road	194'72	148'22	46'50
	Cherry Ground, W. of road, ½ mile S.W. by S. of church	189'24	147'04	42'20
	N. of Greengate, W. of road, ½ mile S.W. by S. of church	173'46	127'26	46'20
Wendling	A little more than ½ mile S.W. of church	182'82	175'18	7'64

Mr. BALDWIN LATHAM says that "the subterranean water, as ascertained by wells sunk in the Boulder Clay at East Dereham, Norfolk, showed that the [slope of the] water-level varied from 2 feet in a mile in the flat tableland to 100 feet in a mile in the valleys." *Rep. Brit. Assoc.* 1876, *Sections*, p. 227 (1877).

The following levels above Ordnance Datum were also obtained by Mr. LATHAM:—

	FEET.
<i>Swanton Morley</i> .—Surface of water of River Wensum, $\frac{1}{4}$ mile N.E. of church	61·39
Surface of Chalk, about $\frac{1}{4}$ mile N.E. of church	79·47
" " " "	75·63
Springs in Chalk, " " "	75·00
" " " "	72·00
<i>North Tuddenham</i> .—Surface of water of tributary of River Wensum, $\frac{1}{4}$ mile S.W. of church	100·32

In the Annual Report for the year 1881, of the Medical Officer of Health (H. B. VINCENT) for the Urban Sanitary District of East Dereham, the following analysis is given of waters drawn from different and widely distant parts of East Dereham, with the object of showing the superiority of the water from the Local Board's well (*see* p. 54). The right-hand column has been added.

Analysis of Different Well-Waters in East Dereham, by
Mr. F. SUTTON.

Constituents in parts per 100,000.	Pump Well by Assembly Rooms.	Rev. W. Freeman's Well.	Colonel Bulwer's Well.	Mr. Fison's Well at Maltings.	Local Board's Well.	
Free Ammonia - - -	0·002	0·004	0·004	0·003	0·020	·014
Organic Nitrogen, as Albumenoid Ammonia -	0·009	0·009	0·008	0·005	0·003	·002
Chlorine - - -	5·900	3·800	4·100	3·600	1·500	1·05
Nitrogen, as Nitrates and Nitrites - - -	1·540	1·129	0·574	0·710	0·	0·
Total Solid Matters in Solution - - -	74·800	60·400	60·600	56·200	22·000	15·4
Total Hardness (Clarke's scale) - - -	36 deg.	35 deg.	31·5 deg.	33 deg.	16 deg.	(This column gives the figures in grains per gal.)
Hardness after boiling for half-an-hour (Clarke's scale) - - -	11·7 deg.	9·2 deg.	6·2 deg.	7·8 deg.	4 deg.	

APPENDIX. WELL-SECTIONS

The figures stand for feet.

BARNHAM BROOM. In the village.
Sunk and communicated by Mr. Thuxton, of Hethersett.—F. J. B.
Boulder Clay, to gravel, 25 feet.

BYLAUGH PARK. Brickyard about three quarters of a mile N.E. by N.
of the church.
Shaft 80 feet ; the rest bored.
Water about 77 feet down.

[Drift.] To Chalk (no record of the beds passed through), 80
Chalk - - - - - 40

The information respecting this well was communicated on the spot, in August 1883, by the manager of the brickyard, who stated that his family had worked it for between 60 and 70 years. The well was sunk about 50 or 60 years ago [1823-1833], and the boring was made in hopes of getting a better supply of water. There were six hollow trunks of trees inserted, with suckers 60 feet down ; but the well on most occasions was soon pumped dry, and it has not been used for about 30 years. The brickyard is now supplied with water conveyed in pipes from the river, being forced up by means of the water-wheel at Elsing Mill. See account of well at Elsing.

CARLTON FOREHOE. At the School.
Sunk and communicated by Mr. Thuxton, of Hethersett.—F. J. B.
Boulder Clay, 25 feet.

EAST DEREHAM. Near the National School, about three eighths of a mile
N.E. of St. Nicholas' Church.
Level of water, 30 feet down.

Post-Glacial.	Brown loam	-	14	} 35
Glacial Drift {	Boulder Clay	-	2 to 3	
	Gravel and sand	-	18	

EAST DEREHAM. Waterworks, a little more than half a mile
N.E. by N. of St. Nicholas' Church. 1880.
J. H. Blake ; Proc. Norwich Geol. Soc. pt. v., pp. 126-128 (1881), with some
further particulars.

216 feet above Ordnance Datum.

Shaft and cylinders 94 feet, the rest bored (10 inches diameter to the
depth of about 100 feet, then 8 inches).

Water rises to 62 feet below the surface ; supply abundant.

A most careful record of the formations penetrated was kept by the contractor, Mr. J. Villiers of Beverley, by whom it was communicated. I also at various times inspected the operations, and carefully examined specimens of the formations passed through.

		THICKNESS.	DEPTH.
[Plateau gravel, &c., 19 feet.]	Soil - - - - -	2	2
	Brown sand and gravel - - - - -	5½	7½
	Brown loam with flints - - - - -	4	11½
	Brown strong clay with flints - - - - -	6½	18
[Upper.]	Brown sand and gravel - - - - -	1	19
	Boulder Clay, grey marly clay, with chalk, flints, &c - - - - -	6	25
	Brown sand and gravel - - - - -	3	28
	Coarse flints and gravel - - - - -	10	38
[Middle Glacial, 69 feet.]	Light-brown sand and gravel, with chalk grains and occasional large flints - - - - -	18	56
	Red sand and gravel - - - - -	14	70
	Light-red sand - - - - -	20	90
	Red sand and small flints - - - - -	4	94
[Lower.]	Boulder Clay, consisting of dark bluish-grey marly clay, with pieces of chalk and fragments of marine shells - - - - -	26	120
	Soft marly chalk - - - - -	10	130
[Chalk, 65 feet.]	Soft chalk, with 5 beds of rotten* flint, the middle one 6 inches thick, the rest 4 inches - - - - -	27	157
	Rotten* chalk - - - - -	28	185

* So described by the contractor.

The trial-boring, commenced on the 4th November 1879, was completed on the 24th January 1880. The progress of the boring, up to January 10th, averaged 3 feet per day until a depth of 180 feet was reached. A difficulty then ensued in keeping the bore-hole open, the chalk being very soft and described as like mud. When a depth of 185 feet had been reached, a test of 72 hours' continuous pumping was made direct from the bore-hole, and water was obtained at the rate of from 60 to 70 gallons per minute, or about 98,000 gallons per day of 24 hours. This result being deemed satisfactory, the boring was not continued.

Water was first met with at a depth of 60 feet, in the red sand and gravel, and continued to a depth of 94 feet, until the Lower Boulder Clay (dark grey marly clay) was reached. The bore-hole was tubed as the work proceeded, but, of the 185 feet bored, only 167 were tubed, and the water stood at 62 feet down. Thus, there was apparently only two feet difference of level between the water that was first met with in the red sand and gravel and that which was supposed to be independent of it, and to have risen afterwards in the tube direct from the Chalk. This fact, I considered, was somewhat ominous, for if the sources of the supply were perfectly distinct, and there was no connexion between the water in the Chalk and that in the Glacial sand above, it was, to say the least, a curious coincidence that the level of the water in both cases should have been nearly the same. With reference to this opinion Mr. F. SUTTON (County Analyst) remarked, "that he was afraid there must be an admixture of the upper and lower waters to which reference had been made, because he never before saw a sample of 'chalk-water' which contained so little solid matter as that obtained from this boring. There must be an admixture of the 'sand-water' with that of the 'chalk-water'; and if the blue marl [Lower Boulder Clay] was fissured, that would most likely be the case. The hardness given in his analysis was 16 deg. (Clarke's scale). That was most exceptional for 'chalk-water'; and it was evident to him that some softer water must have become mixed with it. But that had nothing to do with its sanitary qualities, for the water seemed to be almost perfect, with the exception of the free ammonia, which was sure to be met with in newly-opened wells."

"This water is practically free from organic matter of any kind, and in my opinion does not contain a trace of sewage impurity. The free ammonia is rather large, but this is invariably the case with 'chalk wells' when first drawn upon, and will lessen as the well is used. In my opinion the water

will turn out to be one of the purest supplies in Norfolk, and not excessively hard.”*

The analysis of the water is given in the table, p. 53.

“The flow of water from the Chalk is governed by a sluice-valve at the well-bottom, by which (from above) the water can be shut off, and the well pumped dry for any purposes that might be required. . . . From the well the water is pumped into an elevated tank holding 40,000 gallons, and from thence, through an 8-inch sluice-valve, into the 8-inch main service, etc.” (Mr. W. H. NANKIVELL, Surveyor to Local Board, in the Report of the Medical Officer of Health for 1881).

* *Proc. Norwich Geol. Soc.*, vol. i. pt. v., p. 128.

EASTON. New Rectory, east of the church. From Mr. F. J. BENNETT'S Notes.

Gravel, to Boulder Clay, 30 feet.

EAST TUDDENHAM. In the village.

Sunk and communicated by Mr. Thuxton, of Hethersett (F. J. B.)

Water rose 3 feet.

Boulder Clay, to sand, 15 feet.

ELSING. Near the church.

Sunk and communicated by Mr. Thuxton (F. J. B.)

Chalk, 20 feet.

ELSING. To the west of Elsing Mill there is a well near the river, in the marsh-land, from which water is pumped up to Bylaugh Park. This well, I was told (on the spot) was sunk through the alluvial deposits into the Chalk, of which a considerable thickness was pierced, to a depth of 70 feet. I was unable to ascertain the thickness or character of the alluvial deposits passed through; but was informed that the supply of water from the Chalk not being found sufficient, water from the river was allowed to enter the well, and that this water is now used.

GREAT MELTON. In village.

Sunk and communicated by Mr. Thuxton (F. J. B.)

Boulder Clay, to sand, 20 feet.

LITCHAM. North of Beck's Farm.—From Mr. H. B. WOODWARD'S Notes.
Coarse (Plateau) Gravel, 12 feet.

LYNG. Lyng High House, a mile and a quarter S.E. by S. of the church.

Boulder Clay, to sand and water, 60 feet.

36 cattle, suffering with the plague, were killed in 1865, and are said to have been buried in the sand at the bottom of the pit (see p. 36) about 150 to 180 yards distant.

MILEHAM. From Mr. H. B. WOODWARD'S Notes.

Wells 15 to 40 feet deep. Water generally good.

NORTH TUDDENHAM. The Rectory.

Grey Boulder Clay, to light-brown sand, with water, 11 feet.

NORTH TUDDENHAM. Cottage opposite the entrance-gates of the Rectory.

Greyish and bluish Boulder Clay, to sand with water, 15 feet.

SAHAM. Park Farm.

Sunk and communicated by Mr. Thuxton (F. J. B.)

Boulder Clay (not bottomed), 60 feet.

THUXTON. High House.

Sunk and communicated by Mr. Thuxton (F. J. B.)

Boulder Clay, 60 feet.

WELBORNE. Brickyard a little more than a mile S.W. by W. of the church (p. 37). Information from the foreman.

[Glacial	{ Chalky Boulder Clay	-	-	14
Drift.]	{ Brown sand and loam interstratified	-	-	20
	{ Whitish sand	-	-	26
				60

INDEX.

*Names of places not in the district have * prefixed.*

Acidulated Water, action of, 37, 40, 44.
 Alderfield, 7, 15, 16.
 Algarsthorpe, 11, 44.
 Alluvium, 48-49.
 Analysis of Well-Waters in East Dereham, 53.
 Area treated of, 1.
 Ashill, 11, 21.
 Attlebridge, 7, 11, 15, 17, 20, 31, 48.

Bacon, R.N., 51.
 Barnham Broom, 27, 37, 38, 45, 54.
 Bauburgh, 11, 17, 37, 45.
 „ Hangings, 15, 17, 30.
 Bawdeswell, 23, 32, 42.
 *Beccles, 26.
 Beck Common, 17.
 „ Hall, 19, 23.
 Bedding in Boulder Clay, appearance of, 36.
 Beeston, 11, 34, 40, 46, 52.
 Beetley, 34.
 Bennett, F. J., 11, 21, 26, 31, 43-45, 47, 54, 56.
 Berry Bridge, 45.
 Bickerstone, 45.
 Billingford, 5, 11, 17-19, 22, 31, 39, 41.
 Bittenham Heath, 32.
 Blackwater River, part of the Yare, 2.
 Bones in Alluvium, 48.
 Booton, 24, 33.
 Borings, *see* Wells.
 Boulder clay, Lower 10, 16, 18-21, 55.
 „ Upper, 29-38, 54-56.
 „ used for interior lining of walls of houses, 40.
 Boulders in Gravel, 26, 27, 28.
 „ Lower Glacial Loam, 18, 20.
 „ Plateau Gravel, 39, 43.
 „ Upper Boulder Clay, 29, 32, 33, 34, 35, 36.
 „ Valley Gravel, 46, 47.
 Bow Hill, 44.
 Brandiston, 22, 24, 33.
 Brandon Parva, 27.
 Brickearth, 10, 24, 37, 39, 40, 50.
 Bricks, 50.
 Brisley, 25, 33, 40, 41.
 Building-stones, 50.
 Bure Valley Beds, 14.
 Burwood Hall, 33.

*Bury St. Edmunds, 2.
 Bylaugh, 5, 6, 19, 20, 23, 32, 42, 47, 51, 54, 56.
 Cannon-shot Gravel, 31, 39, 41, 44.
 Carbonaceous matter, 22, 43.
 Carlton Forehoe, 11, 21, 38, 54.
 Carstone, bits of, in gravel, 43.
 Cavelly Farm, 43.
 Cawston, 33.
 Chalk, 5.
 „ contortions and undulations in, 7.
 „ disturbed or glaciated, 7, 8, 10, 11, 37.
 „ fossils of the, 6, 7, 8, 9, 10, 11-13.
 „ grains and pebbles, 22, 24, 25, 26, 27.
 „ pipes or pockets in, 6, 7, 41.
 „ rubbly, 6, 7, 10, 11, 26.
 Chalky Clay, apparently transported mass of, in gravel, 25.
 „ Gravel, 23, 43.
 Chillesford Clay, 14.
 Clay-pit Moor, 33.
 Clay-with-flints, 36, 40.
 Colton, 31, 44, 45.
 Coney Hill, 32.
 Contorted Drift, 30.
 Contortions in strata, 24, 27.
 *Corton, 3, 18, 19, 20, 22.
 Costessy, 17, 31, 37.
 Crag, 14, 15, 16.
 Cranworth, 43.
 *Cringelford, 30.
 *Cromer, 3, 22.
 „ Till, 30.

Dillington, 35, 52.
 Drainage-system, 4.
 Drain-pipes, 50.
 Drift, 2-10, 14-16, 18-48, 50, 51, 53-56.
 *Earlham, 30.
 East Bilney, 25, 34, 49.
 „ Bradenham, 28.
 „ Dereham, 2, 19, 22, 26, 27, 35, 39, 40, 41, 50, 52, 53, 54-56.
 „ drainage-works, sections exposed, 27, 28.
 „ Water-Works 41.

- East Tuddenham, 26, 37, 45, 56.
 Eastern and Midlands Railway, 15, 48.
 Easton, 11, 26, 30, 31, 37, 45, 56.
 *Eaton, 30.
 Economic Resources, 50-53.
 Elmham Great Wood, 25.
 Elsing, 10, 18, 20, 21, 25, 36, 47, 54, 56.

 False or oblique-bedding, 24, 25, 26, 46.
 Flood-gravel, 39.
 Forest-bed, 3, 14.
 Formations, Geological, 2.
 Form of the ground and its origin, 3.
 Fossils in Alluvium, 48, 49.
 " " Chalk, 6, 7, 8, 9, 10, 11-13.
 " " Glacial Sand, 22, 24, 35.
 " " Lower Glacial Loam, 18, 19, 20.
 Four Hill Wood, 11, 21.
 Foxley, 19, 23, 32.

 Galley Moor, 35.
 Glacial Drift, 18-38.
 " Lower, 18-21.
 " Middle, 22-28.
 " Upper, 29, 38.
 Godwick, 33.
 *Gorleston, 1, 22, 23.
 Gravel and Sand, 2-4, 6, 7, 9, 10, 14-17, 19, 21-30, 32-35, 37-48, 50, 51, 54-58.
 Great Dunham, 11.
 " Melton, 11, 43-44, 56.
 " Witchingham, 7, 11, 17, 20, 24, 33, 47.
 Gressenhall, 34, 41, 52.
 Griut Mill, 22, 31.
 Guton Hall, 24, 33.

 Hackford, 22, 24.
 *Halesworth, 15.
 *Happisburgh, 3.
 Hardingham, 43, 47.
 Harmer, F.W., 14, 15, 18, 37.
 Haveringland, 33.
 Heavy or stiff lands, 4.
 Heights, 4, 52, 53.
 Hockering, 26.
 Hoe, 22, 25, 35, 41.
 Holm Hale, 43.
 Honingham, 4, 26, 31, 45.
 Horningtoft, 33.

 Indurated Sand, 22, 23, 26, 42.
 *Intwood, 31.
 Ivy Todd, 34.

 Jukes-Browne, A. J., 5.

 Kempstone, 11.
 *Kessingland, 3, 22.
 Kimberley, 43, 47.

 Latham, Baldwin, 51, 53.
 Lawrence Grove, 33.
 Leda-Myalis Bed, 14.
 Lenwade Bridge, 6, 10, 16, 21, 24, 33, 47.
 Letton, 42, 43.
 Levels, 4, 52, 53.
 Lexham Plantation, 11.
 Light lands, 4.
 Limes, 50.
 Lime-kilns, 6, 9, 10, 11, 50.
 Litcham, 4, 5, 9-11, 34, 40, 41, 46, 49, 50, 52, 56.
 " Valley, 33.
 Little Fransham, 4, 52.
 " Witchingham, 24, 43.
 Loam, with Boulders, 18.
 *Lowestoft, 22, 26.
 Lyng, 9, 11, 17, 21, 25-26, 36, 56.

 Manganese-ore in chalk, 10.
 " -staining, 41.
 Manures, 51.
 Marlingford, 11, 17, 45.
 *Martham, 18.
 Mattishall, 27.
 Middle Glacial, 22-28.
 Mileham, 33, 34, 40, 41, 56.
 Moreton, 10, 11, 26, 48.

 Nankivell, W. H., 56.
 Nar or Setchy River and Valley, 2, 4, 46, 49.
 Neat-herds' Moor, 35.
 Necton, 34, 43, 47.
 Newton, E. T., 11, 49.
 Norfolk County School, 5, 6, 39, 41.
 North Elmham, 8, 33, 42.
 " Tuddenham, 28, 37, 45, 52, 53, 56.
 *Norwich, 4, 18, 30.
 Norwich Crag, 14, 15.

 *Ormesby Board, 18.
 Ouse River System, 46.
 Overlapping of beds, 25, 39.
 Owen, Sir R., 49.

 *Pakefield, 3, 22.
 Paramoudras, 25, 27, 35, 36.
 Peat, 48, 49.
 Pebbly Series, 5-7, 9, 14-17.
 Physical Features, 3.
 Pipes in Boulder Clay, 32, 34, 35, 36, 37.
 " (or pockets) in Chalk, 6, 7, 41.
 " in Marly Loam, 19.
 Plateau Drift, (gravel sand and loam), 39-45.
 Pliocene, 14, 15.
 Post Glacial Beds, 39-49.
 Prestwich, Prof. J., 14.

 Reepham, 22, 25.
 Reid, C., 14.
 Repton, 16.
 Reymmerstone, 48.
 Rhodes, J., 5.
 Ringland, 4, 8, 10, 11, 15, 16, 21, 28.

- Rivers of the district, 1, 2.
 Road-Metal, 50.
 Rootlet-bed, 3.
 Rose, C.B., 10, 11, 13, 49.
 Rye Hill, 44.

 Saham, 56.
 Sand, *see* gravel, 2-4, 21-30, 32-35,
 " -galls, 18.
 " indurated, 22, 23, 26.
 " loose, for foundries, &c., 50, 51.
 Scarning, 28, 52.
 Scenery, 4.
 Setchy, *see* Nar.
 Sewage-works at East Dereham, exca-
 vations made for, 27, 28.
 Sharman, G., 11, 49.
 Shells, decorticated condition of, 18.
 " fresh-water in Alluvium, 48, 49.
 " marine, in Glacial Sand, 22, 24,
 25.
 " " in Lower Glacial Loam,
 19, 20.
 Shipdam, 42, 52.
 Silt, 48.
 Southburgh, 43.
 Skeletons, Human, buried in the Chalk,
 6, 7.
 *Southwold, 15.
 Sparham, 6, 11, 17, 20, 24, 47.
 Springs in Chalk, 53.
 Stanfield, 33, 40, 41.
 Stoke, *see* Wissey.
 Stones on end, in gravel, 41, 45.
 Stony bed of the Norwich Crag (?),
 44.
 Sutton, F., 53, 55.
 Swannington, 7, 11, 17, 26, 33, 48.
 Swanton Morley, 8, 9, 20, 35, 36, 42,
 47, 52, 53.

 Taverham, 8, 11.
 Taylor, J. E., 8.
 Telegraph Hill, 30.
 Tiles, 50.
 Tittleshall, 33, 40, 41.
 Thuxton, 43, 56.
 " Mr., 54, 56.

 "Uncallow" (waste material), 23.
 Unconformity of Plateau gravels, 39,
 42.

 Valley-excavation, 4.
 Valley Gravel, 46, 48.
 Vertical beds in Drift, 24.
 Villiers, J., 54.
 Vincent, H.B., 53.

 Warp, and warping, 3, 40, 48.
 Water and Waterworks, 5, 51, 54.
 Watershed or Water-parting, 4.
 Welborne, 37, 45, 56.
 Wells and Borings, 2, 19, 22, 51, 52,
 54-56.
 Well-waters in East Dereham, Analysis
 of, 53.
 Wellingham, 33, 41.
 Wendling, 52.
 Wensum, River and Valley, 1, 2, 4-10,
 18-26, 31, 33, 46-49, 53,
 West Bradenham, 43.
 Westleton Sands and Shingle, 14.
 Weston, 10, 21, 26, 30, 37, 50.
 Weybourn Crag, 15.
 Whipple Green, 43.
 Whitaker, W., 15, 45, 51.
 Whitening, 10, 50.
 Whitwell, 6, 15, 22, 24, 32, 33.
 " Common, 47.
 Wissey or Stoke, River and Valley, 2,
 4, 47.
 Witchingham Moor, 47.
 Wood, S. V., junr., 10, 11, 14, 15, 18,
 22.
 Woodward, H. B., 3, 5, 8, 11, 14, 16,
 17, 30-31, 33-34, 37,
 40-41, 45, 48, 56.
 " S., 5; 11, 16.
 *Woolpit, 24.
 Worthing, 10, 25, 35, 41.
 Wrampingham, 44.

 Yare, River and Valley, 2, 4, 47.
 *Yarmouth, 4, 22.

**LONDON: Printed by EYRE and SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
[18356.—500.—11/88.]**

GENERAL MEMOIRS OF THE GEOLOGICAL SURVEY—continued.

- The WEALD (PARTS of the COUNTIES of KENT, SURREY, SUSSEX, and HANTS). By W. TOPLEY. 17s. 6d.
 The TRIASSIC and PERMIAN ROCKS of the MIDLAND COUNTIES of ENGLAND. By E. HULL. 5s.
 The FENLAND. By S. B. J. SKERTCHLY. 36s. 6d.
 The MANUFACTURE of GUN FLINTS. By S. B. J. SKERTCHLY. 18s.
 The SUPERFICIAL DEPOSITS of SOUTH-WEST LANCASHIRE. By C. E. DE RANCE. 10s. 6d.
 NORTH DERBYSHIRE. By A. H. GREEN, DR. C. LE NEVE FOSTER, and J. R. DAKYNS. 2nd Ed. by A. H. GREEN and A. STRAHAN. 5s. 6d.
 The BURNLEY COAL FIELD. By E. HULL, J. R. DAKYNS, R. H. TIDDEMAN, J. C. WARD, W. GUNN, and C. E. DE RANCE. 12s.
 The YORKSHIRE COALFIELD. By A. H. GREEN, J. R. DAKYNS, J. C. WARD, C. FOX-STRANGWAYS, W. H. DALTON, R. RUSSELL, and T. V. HOLMES. 42s.
 The EAST SOMERSET and BRISTOL COALFIELDS. By H. B. WOODWARD. 18s.
 The SOUTH STAFFORDSHIRE COAL-FIELD. By J. B. JUKES. (3rd Edit.) (*Out of print.*) 2s. 6d.
 The WARWICKSHIRE COAL-FIELD. By H. H. HOWELL. 1s. 6d.
 The LEICESTERSHIRE COAL-FIELD. By EDWARD HULL. 3s.
 RUPTIVE ROCKS of BRENT TOR. By F. RUTLEY. 15s. 6d.
 PELSTIC LAVAS of ENGLAND and WALES. By F. RUTLEY. 9d.
 MOLDERNESS. By C. REID. 4s.
 BRITISH ORGANIC REMAINS. DECADES I. to XIII., with 10 Plates each. Price 4s. 6d. each 4to; 2s. 6d. each 8vo.
 MONOGRAPH I. On the Genus PTERYGOTUS. By T. H. HUXLEY, and J. W. SALTER. 7s.
 MONOGRAPH II. On the Structure of the BELEMNITIDÆ. By T. H. HUXLEY. 2s. 6d.
 MONOGRAPH III. On the CROCODYLIAN REMAINS found in the ELGIN SANDSTONES. By T. H. HUXLEY. 14s. 6d.
 MONOGRAPH IV. On the CHIMÆROID FISHES of the British Cretaceous Rocks. By E. T. NEWTON. 5s.
 The VERTEBRATA of the FOREST BED SERIES of NORFOLK and SUFFOLK. By E. T. NEWTON. 7s. 6d.
 CATALOGUE of SPECIMENS in the Museum of Practical Geology, illustrative of British Pottery and Porcelain. By Sir H. DE LA BECHE and TRENHAM REEKS. 155 Woodcuts. 2nd Ed. by T. REEKS and F. W. RUDLER. 1s. 6d.; 2s. in boards.
 A DESCRIPTIVE GUIDE to the MUSEUM of PRACTICAL GEOLOGY, with Notices of the Geological Survey, the School of Mines, and the Mining Record Office. By ROBERT HUNT and F. W. RUDLER. 6d. (3rd Ed.) (O. P.)
 A DESCRIPTIVE CATALOGUE of the ROCK SPECIMENS in the MUSEUM of PRACTICAL GEOLOGY. By A. C. RAMSAY, H. W. BRISTOW, H. BAUERMAN, and A. GEIKIE. 1s. (3rd Edit.) (*Out of print.*) 4th Ed. in progress.
 CATALOGUE of the FOSSILS in the MUSEUM of PRACTICAL GEOLOGY:
 CAMBRIAN and SILURIAN, 2s. 6d.; CRETACEOUS, 2s. 9d.; TERTIARY and POST-TERTIARY 1s. 8d.

SHEET MEMOIRS OF THE GEOLOGICAL SURVEY.

Those marked (O. P.) are Out of Print.

- 1 - POLKESTONE and RYE. By F. DEEW. 1s.
 7 - PARTS of MIDDLESEX, &c. By W. WHITAKER. 2s. (O. P.)
 10 - TERTIARY FLUVIO-MARINE FORMATION of the ISLE of WIGHT. By EDWARD FORBES.
 11 - THE ISLE OF WIGHT. By H. W. BRISTOW. 6s. (O. P.)
 12 - S. BERKSHIRE and N. HAMPSHIRE. By H. W. BRISTOW and W. WHITAKER. 3s. (O. P.)
 13 - PARTS of OXFORDSHIRE and BERKSHIRE. By E. HULL and W. WHITAKER. 3s. (O. P.)
 14 - PARTS of WILTS. and GLOUCESTERSHIRE. By A. C. RAMSAY, W. T. AVELINE, and E. HULL. 8d.
 15 - CHELTENHAM. By E. HULL. 2s. 6d.
 16 - BANBURY, WOODSTOCK, and BUCKINGHAM. By A. H. GREEN. 2s.
 17 SW - WOODSTOCK. By E. HULL. 1s.
 18 - N. W. ESSEX & N. E. HERTS. By W. WHITAKER, W. H. PENNING, W. H. DALTON, & F. J. BENNETT. 3s.
 19 SW - COLCHESTER. By W. H. DALTON. 1s. 6d.
 20 SE - EASTERN END of ESSEX (WALTON NAZE and HARWICH). By W. WHITAKER. 9d.
 21 NW, NE - IPWICH, HADLEIGH, and FELIXSTOW. By W. WHITAKER, W. H. DALTON, and F. J. BENNETT.
 22 S, 50 SE - ALDBOROUGH, &c. By W. H. DALTON. Edited, with additions, by W. WHITAKER. 1s.
 23 N - SOUTHWOLD. By W. WHITAKER. 2s. 6d.
 24 SW - STOWMARKET. By W. WHITAKER, F. J. BENNETT, and J. H. BLAKE. 1s.
 25 NW - DISS, EYE, &c. By F. J. BENNETT. 2s.
 26 NE - HALESWORTH and HARLESTON. By W. WHITAKER and W. H. DALTON. 1s.
 27 SW - CAMBRIDGE. By W. H. PENNING and A. J. JUKES-BROWNE. 4s. 6d.
 28 SE - BURY ST. EDMUNDS and NEWMARKET. By F. J. BENNETT, J. H. BLAKE, and W. WHITAKER. 1s.
 29 SE - PART of NORTHAMPTONSHIRE. By W. T. AVELINE and RICHARD TRENCH. 8d.
 30 NE - PARTS of NORTHAMPTONSHIRE and WARWICKSHIRE. By W. T. AVELINE. 8d. (O. P.)
 31 SE - PART of LEICESTERSHIRE. By W. TALBOT AVELINE, and H. H. HOWELL. 8d. (O. P.)
 32 - RUTLAND, &c. By J. W. JUDD. 12s. 6d.
 33 NE, SE - NORWICH. By H. B. WOODWARD. 7s.
 34 SW - ATTLEBOROUGH. By F. J. BENNETT. 1s. 6d.
 35 E - CROMER. By C. REID. 6s.
 36 NW, SW - FAKENHAM, WELLS, &c. By H. B. WOODWARD. 2s.
 37 - S. W. LINCOLNSHIRE, &c. By A. J. JUKES-BROWNE and W. H. DALTON. 4s.
 38 NE - NOTTINGHAM. By W. T. AVELINE. (2nd Ed.) 1s.
 39 NW - RHYL, ABERGELE, and COLWYN. By A. STRAHAN. (Notes by R. H. TIDDEMAN.) 1s. 6d.
 40 NW - PRESCOT, LANCASHIRE. By E. HULL. (3rd Ed. With additions by A. STRAHAN.) 3s.
 41 NE - ALTRINCHAM, CHESHIRE. By E. HULL. 8d. (O. P.)
 42 SW - CHESTER. By A. STRAHAN. 2s.
 43 NW, SW - STOCKPORT, MACCLESFIELD, CONGLETON, & LEEK. By E. HULL and A. H. GREEN. 4s.
 44 SE - PARTS of NOTTINGHAMSHIRE and DERBYSHIRE. By W. T. AVELINE. (2nd Ed.) 6d.
 45 NE - PARTS of NOTTINGHAMSHIRE, YORKSHIRE, and DERBYSHIRE. By W. T. AVELINE. 8d.
 46 - LINCOLN. By W. A. E. USSHER, A. J. JUKES-BROWNE, and A. STRAHAN. 3s.
 47 - EAST LINCOLNSHIRE. By A. J. JUKES-BROWNE. 3s. 6d.
 48 NW - PARTS of NOTTS, YORKSHIRE, and DERBYSHIRE. (2nd Ed.) By W. T. AVELINE. 6d.
 49 SW - BARNSELEY. By A. H. GREEN. 9d.
 50 SW - OLDHAM. By E. HULL. 2s.
 51 SE - PART of the YORKSHIRE COAL-FIELD. By A. H. GREEN, J. R. DAKYNS, and J. C. WARD. 1s.
 52 NE - DEWSBURY, &c. By A. H. GREEN, J. R. DAKYNS, J. C. WARD and R. RUSSELL. 6d.
 53 SE - BOLTON, LANCASHIRE. By E. HULL. 2s.
 54 SW - WIGAN. By EDWARD HULL. (2nd Ed.) 1s. (O. P.)
 55 SE - THE COUNTRY between LIVERPOOL and SOUTHPORT. By C. E. DE RANCE. 3d. (O. P.)
 56 NE - SOUTHPORT, LYTHAM, and SOUTH SHORE. By C. E. DE RANCE. 6d.
 57 SW - THE COUNTRY between BLACKPOOL and FLEETWOOD. By C. E. DE RANCE. 6d.
 58 NW - SOUTHERN PART of the FURNESS DISTRICT in N. LANCASHIRE. By W. T. AVELINE. 6d.
 59 SE - BRADFORD and SKIPTON. By J. R. DAKYNS, C. FOX-STRANGWAYS, R. RUSSELL and W. H. DALTON. 6d.
 60 NW - NORTH and EAST of HARBOROUGH. By C. FOX-STRANGWAYS. 6d.
 61 NE - THE COUNTRY between YORK and MALDON. By C. FOX-STRANGWAYS. 1s. 6d.
 62 NW - CARBONIFEROUS ROCKS N. and E. of LEEDS, and the PERMIAN and TRIASSIC ROCKS about TADCASTER. By W. T. AVELINE, A. H. GREEN, J. R. DAKYNS, J. C. WARD, and R. RUSSELL. 6d. (O. P.)

SHORT MEMOIRS OF THE GEOLOGICAL SURVEY—continued.

- 93 SE, 94 W COUNTRY between YORK & HULL. By J. R. DAKYNS, C. FOX-STRANGWAYS, and A. G. CAMERON. 1s. 6d.
 94 NW - DRIFFIELD. By J. R. DAKYNS and C. FOX-STRANGWAYS. 9d.
 94 NE - BRIDLINGTON BAY. By J. R. DAKYNS and C. FOX-STRANGWAYS. 1s.
 95 SW, SE - SCARBOROUGH and FLAMBOROUGH HEAD. By C. FOX-STRANGWAYS. 1s.
 95 NW - WHITBY and SCARBOROUGH. By C. FOX-STRANGWAYS and G. BARROW. 1s. 6d.
 96 SE - NEW MALTON, PICKERING, and HELMSLEY. By C. FOX-STRANGWAYS. 1s.
 96 NE - ESKDALE, ROSEDALE, &c. By C. FOX-STRANGWAYS, C. REID and G. BARROW. 1s. 6d.
 96 NW, SW NORTHALLERTON and THIRSK. By C. FOX-STRANGWAYS, A. G. CAMERON, and G. BARROW. 1s. 6d.
 98 SE - KIRKBY LONSDALE and KENDAL. By W. T. AVELINE, T. MC K. HUGHES, and R. H. TIDDEMAN. 2s.
 98 NE - KENDAL. By W. T. AVELINE & T. MC K. HUGHES. 2nd Ed. by A. STRAIHAN. 2s.
 101 SE - NORTHERN PART of the ENGLISH LAKE DISTRICT. By J. C. WARD. 9s.
 104 SW, SE NORTH CLEVELAND. By G. BARROW. 1s. 6d.
 108 SE - OTTERBURN and ELSDON. By HUGH MILLER. (Notes by C. T. CLOUGH.) 2s. 6d.

THE MINERAL DISTRICTS OF ENGLAND AND WALES ARE ILLUSTRATED BY THE FOLLOWING PUBLISHED MAPS OF THE GEOLOGICAL SURVEY.

COAL-FIELDS OF ENGLAND AND WALES.

Scale, one inch to a mile.

Anglesey, 78 (SW).
 Bristol and Somerset, 19, 35.
 Coalbrook Dale, 61 (NE & SE).
 Clee Hill, 53 (NE, NW).
 Flintshire and Denbighshire, 74 (NE & SE), 79 (NE, SE).
 Derby and Yorkshire, 71 (NW, NE & SE), 82 (NW & SW), 81 (NE), 87 (NE, SE), 88 (SE).
 Forest of Dean, 43 (SE & SW).
 Forest of Wyre, 61 (SE), 55 (NE).
 Lancashire, 80 (NW), 81 (NW), 89, 88 (SW, NW).
 Leicestershire, 71 (SW), 63 (NW).
 Northumberland & Durham, 103, 105, 106 (SE), 109 (SW, SE).
 N. Staffordshire, 72 (NW), 72 (SW), 73 (NE), 80 (SE), 81 (SW).
 S. Staffordshire, 54 (NW), 62 (SW).
 Shrewsbury, 60 (NE), 61 (NW & SW).
 South Wales, 36, 37, 38, 40, 41, 42 (SE, SW).
 Warwickshire, 62 (NE SE), 63 (NW SW), 54 (NE), 53 (NW).
 Yorkshire, 88 (NE, SE), 87 (SW), 92 (SE), 93 (SW).

GEOLOGICAL MAPS.

Scale, six inches to a mile.

The Coal-fields and other mineral districts of the N. of England are published on a scale of six inches to a mile, at 4s. to 6s. each. MS. Coloured Copies of other six-inch maps, not intended for publication, are deposited for reference in the Geological Survey Office, 28, Jermyn Street, London.

Lancashire.

- | | | |
|----------------------|---------------------------|---------------------------|
| Sheet. | Sheet. | Sheet. |
| 15. Ireleth. | 73. Todmorden. | 97. Oldham. |
| 16. Ulverstone. | 77. Chorley. | 100. Knowsley. |
| 17. Cartmel. | 78. Bolton-le-Moors. | 101. Billinge. |
| 22. Aldingham. | 79. Entwistle. | 102. Leigh, Louton. |
| 47. Clitheroe. | 80. Toffington. | 103. Ashley, Eccles. |
| 48. Colne. | 81. Wardle. | 104. Manchester, Salford. |
| 49. Lanesshaw Br. | 84. Ormskirk. | 105. Ashton-under-Lyne. |
| 55. Whalley. | 85. Standish. | 106. Liverpool. |
| 56. Haggate. | 86. Adlington. | 107. Prescott. |
| 57. Winewall. | 87. Bolton-le-Moors. | 108. St. Helen's. |
| 61. Preston. | 88. Bury, Heywood. | 109. Winwick. |
| 62. Balderstone. | 89. Rochdale, &c. | 111. Cheedale. |
| 63. Accrington. | 92. Bickerstaffe. | 112. Stockport. |
| 64. Burnley. | 93. Wigan. | 113. Part of Liverpool. |
| 65. Stiperden Moor. | 94. West Houghton. | |
| 39. Layland. | 95. Radcliffe. | |
| 70. Blackburn. | 96. Middleton, Prestwich. | |
| 71. Haslingden. | | |
| 72. Cliviger, Bacup. | | |

Durham.

- | | | |
|----------------|------------------|--------------------|
| 1. Ryton. | 6. Winlaton. | 11. Ebchester. |
| 2. Gateshead. | 7. Washington. | 12. Tantonby. |
| 3. Jarrow. | 8. Sunderland. | 13. Chester-le-St. |
| 4. S. Shields. | 9. ——— | 16. Hunstanworth. |
| 5. Greenside. | 10. Edmondbyers. | 17. Wakerley. |

Durham—continued.

- | | | |
|---------------------|--------------------|---------------------|
| Sheet. | Sheet. | Sheet. |
| 18. Muggleswick. | 25. Wolsingham. | 38. Maize Beck. |
| 19. Lanchester. | 26. Brancepeth. | 41. Cockfield. |
| 20. Hetton-le-Hole. | 30. Benny Seat. | 42. Bp. Auckland. |
| 22. Wear Head. | 32. White Kirkley. | 46. Hawksley Hill. |
| 23. Eastgate. | 33. Hamsterley. | 52. Barnard Castle. |
| 24. Stanhope. | 34. Whitworth. | 53. Winstan. |

Northumberland.

- | | | |
|---------------------|----------------------|--------------------|
| 44. Rothbury. | 80. Cramlington. | 98. Walker. |
| 45. Longframington. | 81. Barsdon. | 101. Whitfield. |
| 46. Broombill. | 82. NE. of Gilsdale. | 102. Allendale. |
| 47. Coquet Island. | 83. Coadley Gate. | 103. Slaley. |
| 54. Longhorsley. | 87. Heddon. | 105. Newlands. |
| 55. Ugham. | 88. Long Benton. | 106. Blackpool Br. |
| 56. Druridge Bay. | 89. Tynemouth. | 107. Allendale. |
| 63. Netherwitton. | 91. Greenhead. | 108. Blanchland. |
| 64. Morpeth. | 92. Haltwhistle. | 109. Shotleyfield. |
| 65. Newbiggin. | 94. Hexham. | 110. Wellhope. |
| 72. Bedlington. | 95. Corbridge. | 111. Allenheads. |
| 73. Blyth. | 96. Horsley. | 112. ——— |
| | 97. Newcastle. | |

Cumberland.

- | | | |
|-------------------|-----------------|------------------------|
| 55. Searness. | 65. Dockraye. | 74. Westwater. |
| 56. Skiddaw. | 69. Buttermere. | 75. Stonethwaite Fell. |
| 63. Thackthwaite. | 70. Grange. | |
| 64. Keswick. | 71. Helvellyn. | |

Westmorland.

- | | | |
|-----------------|--------------------|---------------|
| 2. Tees Head. | 12. Patterdale. | 25. Grasmere. |
| 6. Dufton Fell. | 18. Near Grasmere. | 38. Kendal. |

Yorkshire.

- | | |
|----------------------|-----------------------------|
| 116. Conistone Moor. | 260. Honley. |
| 133. Kirkby Malham. | 261. Kirkburton. |
| 184. Dale End. | 262. Darton. |
| 185. Kildwick. | 263. Hemsworth. |
| 200. Keighley. | 264. Campsall. |
| 201. Bingley. | 272. Holmfirth. |
| 202. Calverley. | 273. Penistone. |
| 203. Seacroft. | 274. Barnsley. |
| 204. Aberford. | 275. Darfield. |
| 215. Peeke Well. | 276. Brodsworth. |
| 216. Bradford. | 281. Langwell. |
| 217. Calverley. | 282. Wortley. |
| 218. Leeds. | 283. Wath upon Dearne. |
| 219. Kippax. | 284. Conisborough. |
| 231. Halifax. | 287. Low Bradford. |
| 232. Birstal. | 288. Ecclesfield. |
| 233. East Ardsley. | 289. Rotherham. |
| 234. Castleford. | 290. Braithwell. |
| 246. Huddersfield. | 293. Hallam Moors. |
| 247. Dewsbury. | 295. Handsworth. |
| 248. Wakefield. | 296. Loughton-en-le-Morden. |
| 249. Pontefract. | 299. ——— |
| 250. Darrington. | 300. Harthill. |

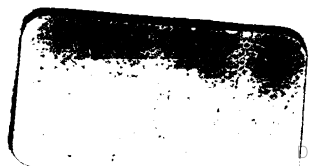
MINERAL STATISTICS.

Embracing the produce of Coals, Metallic Ores, and other Minerals. By E. HUNT. From 1853 to 1857, inclusive, 1s. 6d. each. 1858, *Part I.*, 1s. 6d.; *Part II.*, 5s. 1859, 1s. 6d. 1860, 3s. 6d. 1861, 2s.; and Appendix, 1s. 1862, 2s. 6d. 1863, 2s. 6d. 1864, 2s. 1865, 2s. 6d. 1866 to 1881, 2s. each.
 (These Statistics are now published by the Home Office, as parts of the *Reports of the Inspectors of Mines.*)

THE IRON ORES OF GREAT BRITAIN.

Part I. The North and North Midland Counties of England (*Out of print*). *Part II.* South Staffordshire. Price 1s.
Part III. South Wales. Price 1s. 3d. *Part IV.* The Shropshire Coal-field and North Staffordshire. 1s. 3d.

Date Due





3 2044 102 950 805